SIXTY-SEVENTH YEAR

# SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CIV.
NUMBER 24

NEW YORK, JUNE 17, 1911

10 CENTS A COPY
$3.00 A YEAR

This view of the new Grand Central Station as it will appear in eighteen months' time at completion, is taken from Park Avenue, looking north. The approach, by a bridge over Forty-second Street, will lead to a driveway, encircling the station building, which will connect with Park Avenue to the north. The station building at street level will be 300 feet wide, 600 feet long and 105 feet high. Below street level it will be 480 feet wide, 745 feet long, and 45 feet deep, the trains being handled on two separate levels. The total area of the terminal will be 69.8 acres.

THE WORLD'S GREATEST RAILWAY TERMINAL.—[See page 594.]

# SCIENTIFIC AMERICAN

Founded 1845

NEW YORK, SATURDAY, JUNE 17, 1911

Published by Munn & Co., Incorporated. Charles Allen Munn, President; Frederick Converse Beach, Secretary and Treasurer; all at 361 Broadway, New York

Entered at the Post Office of New York, N. Y., as Second Class Matter





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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.


*The purpose of this journal is to record accurately and in simple terms, the world's progress in scientific knowledge and industrial achievement. It seeks to present this information in a form so readable and readily understood, as to set forth and emphasize the inherent charm and fascination of science.*

## The Steel Railroad Car

IT is difficult to understand why that universal material of construction—steel—should have made so late an entrance into the important field of American railroad car construction. For a given weight, the steel car is far stronger than one of wood; its period of useful life is much longer; it lends itself more readily to a concentration of strength in those parts of the car where it is most needed; it is incombustible; costs less for up-keep; and, most important of all, removes forever from railroad operation those two frightful causes of death and injury in railroad wrecks—fire and telescoping of the cars.

But when the age of the steel passenger car finally arrived, it was ushered in on a scale which reflects the greatest credit upon the Pennsylvania Railroad Company, to whose enterprise some tribute is certainly due in any article dealing with this most important subject. At the same time it should be recorded that while this company was the first to make extensive use of steel cars in trunk line express and local service, credit is also due to the Interborough Company which operates the system of subways through New York city for being, we believe, the first to use all-steel cars in passenger service. Limitations of space prevent any detailed description of the fine equipment which the Pennsylvania Railroad Company has placed in service; but in the current issue of the SUPPLEMENT will be found an illustrated article dealing with this subject at some length.

Briefly stated, the principal advantages of the new construction are—first, the provision of a massive, longitudinal, box-girder running entirely beneath the center of the car from buffer to buffer, to which are attached the couplings and through which are transmitted the heavy shocks incidental to railroad service. Second, the provision of means for locking the abutting platforms of cars very firmly together so as to prevent one platform from mounting the other and acting as a knife to cut its way through the adjoining car in the process of telescoping. Third, the provision in this last connection of massive, vertical steel framing at the vestibule and the car entrances, of sufficient strength to resist telescoping in case the platforms should overlap in collision; and, lastly, the complete elimination of wood and other combustible material so as to shut out the possibility of fire in case of a bad wreck.

The unqualified success of steel car equipment in active service has led to its adoption by several leading roads, including the New York Central, the New Haven, the Lackawanna, and the Chicago Rock Island & Pacific, all of which are placing steel cars in service as soon as they are available. But in this connection we wish to utter a word of warning. In a long, heavy, and fast train made up of mixed steel and wooden cars, the very elements of strength and resistance to telescoping which render the car a protection to those who use it, make it a menace to the weaker wooden cars which may be sandwiched in between. In case of a head-on collision the momentum of the train is expended in crushing up or splitting open the weakest element in the train. Hence it would be advisable, if a train is to be made up of both wooden and steel cars, that care to be taken always to place the latter immediately behind the locomotive.

## The Law of the Air

THE flying machine and the airship have brought us face to face with new legal problems, that affect not only local conditions, but interstate and international politics as well. The first question that must be decided is this: Has the air-man any right to the atmosphere at all? The old legal maxim that a man owns not only the land upon which his house stands, but also the air above to unlimited height immediately springs to mind. Curious as it may seem, no square decision in which that maxim is involved can be found in all English or American law. On the other hand, there is many a dictum to show that the maxim is rather lightly regarded. Master of the Roles Brett once referred to it as a "fanciful phrase." It is only when the possession of the soil is interfered with that the air-man is likely to infringe upon the rights of property owners. That point of view is taken in most of the European codes. Thus, for example, in the German Civil Code it is stated that a property holder "cannot prohibit such interferences undertaken at such a height or depth that he has no interest in the prevention."

Probably the first laws which will be enacted in this country will concern not property, but lives. In view of some accidents which have occurred at Paris, it seems unlikely that air-craft in Europe will be permitted to fly at will over large cities and communities with the possibility of being compelled to descend because of crippled motors or lack of fuel. On the other hand, the open country and navigable streams will probably be free.

Forced descents may perhaps render it necessary to treat the air-man more leniently than is possible under the common law. In a New York case (Guille against Swann, 19 Johns., 381) decided in 1822, an aeronaut was held responsible not only for the direct damage caused by the descent of his balloon into a garden, but even for the remote damage caused by the crowding of strangers upon the property to satisfy their curiosity. In an article which he published last year in the *American Journal of International Law*, Governor (then Judge) Simeon Baldwin thought it would be advisable to indicate where a landing is prohibited and where it is permitted. It seems to us that in the case of a necessary landing, the aviator should not be made to pay more than the direct damage which he has himself caused. Governor Baldwin has raised the question whether the law of self preservation cannot be invoked by an air-man who is compelled to make an immediate landing to save his own life and by so doing accidentally causes the death of another.

To avoid these forced descents, and to insure careful control of air-craft as far as possible, licenses to navigate the air will undoubtedly be necessary. Most of the bills which are now pending before legislatures provide for such licenses. In the United States it is questionable whether the States should be permitted to issue such licenses in preference to the Federal Government. When air-craft travel at speeds of 40 to 80 miles an hour, it is possible to traverse more than a single State in a day. Must the aviator take out licenses for every State in the Union? Would it not be more desirable to receive a Federal license which would enable him to fly where he pleased? To be sure, automobile licenses granted by one State are respected for a few hours in most States. But the conditions in the air are so different, the distances covered so great, that a similar provision to protect the aeronaut would mean the practical nullification of any State's license act. Moreover, if the Federal Government controls the licensing of steamboats and ships that ply our coasts and streams, why should it not also license air-craft?

Questions of aerial international politics have already given Congresses which have met in Europe no little concern. On the whole, there seems to be a tendency to apply the principles of maritime law to air-craft. Thus, before the American Political Science Association, Mr. Arthur Kuhn suggested that the right of the craft of one nation freely to traverse the airspace of another might be compared with that of the vessel of one State freely to navigate the waters of a co-riparian State. The abortive convention drafted by the International Conference on aerial navigation of 1910, was based entirely upon the provisions of International maritime law. There are the same requirements as to registration and nationality of the air vessels; the same method of determining the fitness of the craft, and the competence of its navigators, and the same regulations applying to the sojourn of air-craft in distress. Provision is also made for the keeping of logs, customs supervision in the atmosphere, the right of police, the regulation of passenger and freight traffic, the prohibition of navigation in certain zones in the vicinity of fortifications. There is even a tendency to incorporate a principle analogous to the three-mile neutral zone of maritime law; but there seems to be no agreement on the height of that zone as yet.

## Renaissance of the Naval Reciprocating Engine

WHEN it was recently announced that the Navy Department had decided to return to the reciprocating engine as a drive for battleships, we expressed astonishment that this should be done at a time when every other naval power was using the steam turbine exclusively. That the action of the Department was based upon fact and sound reasoning, however, is shown by the comparative steaming results obtained from two sister ships, the "North Dakota," which is equipped with turbine engines, and the "Delaware," driven by standard reciprocating engines.

An opportunity for comparison of coal consumption under identical conditions was recently afforded when the two ships were steaming with the North Atlantic fleet, the "North Dakota" in position directly astern of the "Delaware." We are officially informed that average results for ten days show that using coal from the same collier, employing the same auxiliary engines, and steaming at the same speed, of 12 knots, under identical conditions of wind and weather, the "North Dakota" consumed 43 per cent more coal than the "Delaware."

It has always been understood that the turbine showed its best efficiency when it was being driven at full speed, under which conditions its coal consumption is as good if not better than that of the reciprocating engine. At anything less than full speed the turbine consumption becomes relatively larger and at cruising speed considerably so. But it has taken such a test as this, made under seagoing conditions, to show just how extravagant is the coal consumption of the turbine under cruising conditions. At the same time it must be remembered that the turbines of the "North Dakota" represent a comparatively early type, and that in the later designs the coal consumption at moderate speeds has been reduced.

What makes the record of the "Delaware" so very significant is the fact that she recently carried out her annual full-speed trials, at the close of some 19,000 miles of all but continuous steaming, and under conditions which show her reciprocating engines to be remarkably reliable, and capable without any preliminary preparation, of equaling and even surpassing the results obtained during the original acceptance trials. We invite attention to the following facts which are taken from the log of the ship:

Early in the present year the "Delaware" steamed at 12 knots from Cherbourg for Guantanamo, Cuba, where she received wireless orders to proceed at once at 15 knots to Hampton Roads, a further distance of 1,100 miles. She reached Hampton Roads with 500 tons of coal in her bunkers. Here, after thirteen days in port, she received instructions to take the body of the Chilian Minister to Valparaiso, which she did; and after ten days at Valparaiso steamed back around the Horn to Boston. At 5 A. M. of April 26th, when nearing Boston Harbor, a wireless order was received from the Navy Department, to hold the annual "surprise" steam trials of the vessel at once. She reached Boston at 10:30 April 26th, took on a thousand tons of coal and fresh provisions, and left at 9 A. M., April 27th, for the trial course.

This was a surprise trial with a vengeance; for the ship had just concluded some 19,000 miles of steaming without undergoing any dock repair or machinery over-hauling whatsoever. Nevertheless, the "Delaware," steaming for four consecutive hours, at full power, made an average of 21.86 knots, which is nearly a third of a knot more than the 21.56 knots she made on her official trials. But she did even better than that; for on the twenty-four hour continuous run at full power, she averaged 21.32 knots, and this in spite of the fact that she was burning coal only, had her regular watch in the fire rooms and was cleaning fires as usual. A further tribute to her engine room efficiency is found in the fact that the ship has steamed 30,000 miles without any adjustment of her engines.

If there is any better record of motive power efficiency on a modern dreadnought than this, it would give us great pleasure to record it.

# The Interstate Commerce Law

## Its Development and Administration

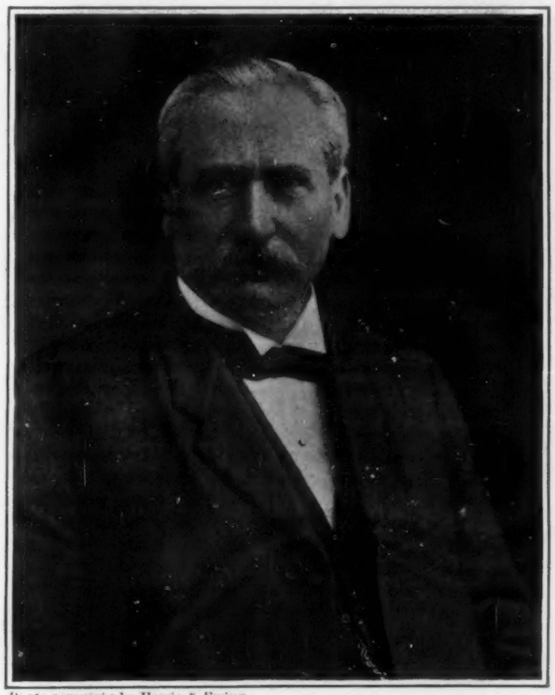
By Judge Judson C. Clements, Chairman of the Interstate Commerce Commission

THE whole structure of interstate commerce regulation, including the federal safety appliance and employees' personal injury laws, is based upon authority vested in Congress by the commerce clause of the constitution. Although the adoption of this provision antedated by some forty years the first mile of railway, its application to other features of commerce pales into insignificance when compared with its practical application to present-day transportation on our nearly two hundred and forty thousand miles of railway. This is one of many illustrations of the great wisdom and keen foresight of the philosophers and patriots who framed the constitution. They did not deal merely with tangible matters in their immediate sight, but constructed upon ever-existing, fundamental principles applicable to whatever changed conditions might arise in the course of human progress. It has been said truly, "Times change and men change with them, but principles never." With the progress of time, circumstances and conditions change, requiring new and suitable rules of action, but the principles of justice governing natural rights are immutable.

For the first fifty years or more of railway transportation, conditions did not strongly demand the exercise of this federal authority; but with the constantly increasing incorporation of separate roads into great systems of through and continuous lines, the combinations of these systems through associations, the suppression or diminution of competition by pooling and otherwise, and the tendency to favor those offering large and frequent shipments to the disadvantage of shippers of less commercial importance, there came general public necessity and demand for relief against the baneful effects of unjust rates and discriminations. This all culminated in the passage of the Cullom-Reagan bill, approved February 4th, 1887, known as the Interstate Commerce Act. There had been no definite legal requirement, nor even manifestation of a public policy that carriers, although they had been and were engaged in a public service affected with a public interest, were under obligation to serve the public on terms of reasonableness and equality. It is not surprising, therefore, that in the contest for business, conducted mainly with a view to corporate gain, there resulted deplorable conditions.

The Act of 1887 in the very nature of the case was experimental and tentative because Congress was then just beginning to blaze the way into a vast jungle to be reclaimed only by new legislation. Naturally, the first step was to turn on the searchlight; hence one conspicuous feature of the new law was its authority and command to the commission "to inquire into the management of the business of common carriers subject to the provisions of this act" and to "keep itself informed as to the manner and method in which the same is conducted;" also to report to Congress "such information and data collected by the commission as may be considered of value in the determination of questions connected with the regulation of commerce, together with such recommendations as to additional legislation relating thereto as the commission may deem necessary."

The fundamentals of this act are that rates, regulations and practices affecting interstate transportation shall be reasonable and just and devoid of undue and unreasonable discriminations; and after the declaration of these principles practically all of the subsequent provisions of the law constitute machinery to give effect to these substantive requirements. It has been said by high authority that the embodiment of these requirements in the act was simply putting into statutory form principles of the common law. Whether or not this be true as to discriminations it certainly is with regard to reasonableness in the amount of rates. Yet up to and for a time after the passage of this act in 1887, it is doubtful if there can be found in any of the courts a record of judgment for damages on account of an unreasonable rate. In practical effect, therefore, this theoretical common-law right of recovery was a dead-letter. The reasons are manifest; there was no requirement for the establishment of rates as a standard to be observed alike as to all shippers; neither was there a satisfactory basis of comparison or other measurement for the determination of the reasonableness of rates. As a practical matter a shipper could not hope to maintain such a contest under the conditions that were then existing.



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Judson C. Clements

**Chairman of the Interstate Commerce Commission.**

The passage of this act was strenuously resisted on many grounds, constitutional and otherwise. It was alleged to be radical, revolutionary, un-American and an unjustifiable interference with the freedom of contract and with ancient commercial usages. It was contended that that government is best that governs least. But the brutal doctrine of the survival of the so-called fittest did not prevail; neither on the other hand did the passage of the act mark a recognition of principles that were radical or revolutionary; but it did give additional evidence of the masterful capacity of the English-speaking people in the interest of long recognized principles of justice to initiate new and necessary remedies and forms of procedure to meet a material change in conditions. This legislation, with its new forms of procedure, was as necessary to meet modern conditions and to remedy a deplorable failure of justice as was the institution in England hundreds of years ago of courts of equity and equity proceedings to remedy the failure of justice under the common law, which proved inadequate in many cases by reason of its universality.

It would be just as reasonable to allow one party to an ordinary legal controversy to determine for himself the rights of both as to permit carriers under modern conditions to finally determine what their patrons shall pay for a transportation service. Experience does not justify the contention formerly made that the interests of the carriers may be relied upon to protect the rights and interests of each of their patrons. There is equal necessity for the determination of controversies of each of these classes by an impartial public tribunal. No specific formula for the exact measurement and ascertainment of the reasonableness of a given rate for a particular service has ever yet been devised. This can only be approximately ascertained by the conscientious application of an impartial judgment to the facts, circumstances and conditions affecting the service in each individual case. It is therefore of the utmost importance not alone for the protection of carrier and shipper, but the consumer as well, that the tribunal applying its judgment in the determination of these matters should be just and keep constantly in mind the necessity for sufficient earnings to provide for efficient service to the public as well as that the public should be protected from excessive rates and unjust discriminations.

While the act as first passed denounced rebates and unjust discriminations, it provided penalties only against carriers for granting rebates; there was no penalty for shippers seeking or accepting unlawful concessions. But within a little more than two years, upon the recommendation of the commission and upon sound principle, Congress provided penalties against shippers as well. Soon thereafter a large shipper and receiver of rebates who was called upon to testify before the commission as to these discriminations refused to do so on the ground of self-incrimination, thus invoking his constitutional protection, notwithstanding that the act provided that while a witness should not be excused under such circumstances from testifying, his testimony should not be used against him in any criminal prosecution. The plea was sustained by the United States Supreme Court, which pointed out, however, that the enactment of a provision protecting a witness altogether from prosecution on account of any matter about which he should be required to testify would not justify his refusal. This resulted in the passage of another act in 1893 in conformity with the suggestion of the Supreme Court. Subsequently the constitutionality of this act was sustained by the Supreme Court.

In the meantime another constitutional question arose involving the validity of a provision authorizing the commission to institute and conduct general inquiries into the conduct of railroads. This provision was sustained by the Supreme Court in a decision of five to three.

Thus for a number of year the authority of the commission to ascertain the facts absolutely necessary to a just determination of questions was impaired and held more or less in abeyance.

In 1897 came the decision of the Supreme Court to the effect that the law did not empower the commission to prescribe a future rate however unreasonable it might find the existing rate to be.

In 1903, following the exposure in a general investigation by the commission of wholesale rebating on important shipments, particularly in the Northwest, the commission attempted through the courts to enjoin carriers engaged in such practices; and while this question was pending in the Supreme Court, the Elkins bill was passed, specially authorizing such injunctions and prescribing larger penalties for discriminations and departures from the published rates. This latest enactment considerably strengthened the law as to discriminations because under the original act it had been held by the courts that a corporation was not indictable and that proof of a departure from published rates established no offense, as that fact of itself did not prove discrimination—that for aught the court might know all shippers might have been given the same unpublished rate without inequality. The amendatory acts heretofore referred to did not, however, strengthen the law against excessive charges.

In 1906, the commission, pursuant to a joint resolution of the Congress, instituted the well-remembered investigations into the relations of carriers to the coal and oil business and producers of those commodities, disclosing most flagrant and extensive discriminations induced to a large extent by the bribery of railway officials and employees and effected by means of various devices. While the investigations were in progress the so-called Hepburn act was passed, increasing in many respects the power to regulate interstate commerce and conferring upon the commission authority upon complaint and full hearing to prescribe for the future just and reasonable rates, regulations and practices in lieu of those found to be unjust and unreasonable; also conferring jurisdiction over express companies, pipe lines and sleeping-car companies and defining transportation so as to include refrigeration, ventilation, elevation and other services theretofore not regarded as part of transportation. This act contains the so-called commodities clause, providing that

"From and after May first, nineteen hundred and eight, it shall be unlawful for any railroad company to transport from any State, Territory, or the District of Columbia, to any other State, Territory, or the District of Columbia, or to any foreign country, any article or commodity, other than timber and the manufactured products thereof, manufactured, mined, or produced by it, or under its authority, or in which it may have any interest, direct or indirect, except such articles or commodities as may be necessary and intended for its use in the conduct of its business as a common carrier."

It also requires the carriers to keep open to inspec-

Charles A. Prouty.

Franklin K. Lane.

Edgar E. Clark.

tion of the commission their books and accounts in such a form as may be prescribed by it and specifies penalties for the falsification, mutilation or destruction of records. The exercise of the commission's authority under this provision has resulted in uniform standards and has afforded a powerful check against unlawful practices, as well as produced a much higher degree of reliability in reports of carriers.

The latest amendment, known as the Mann bill, was enacted in June, 1910, and empowers the commission to suspend the operation of tariffs providing for increased rates, subject to investigation as to their reasonableness and propriety. The enactment of this provision is a distinct recognition of the oft-demonstrated necessity for the prevention of transportation wrongs as the only adequate method of protecting those upon whom injury would fall if the wrongful act should be permitted. In the very nature of the case complete reparation in damages for injuries suffered is for obvious reasons impossible.

The amended act confers upon the commission jurisdiction and authority over telegraph and telephone lines, and also empowers the commission to institute investigations upon its own motion, with authority to make suitable orders therein the same as if formal complaint had been made by a shipper. It also enlarges the powers of the commission with reference to the establishment of through routes and joint rates.

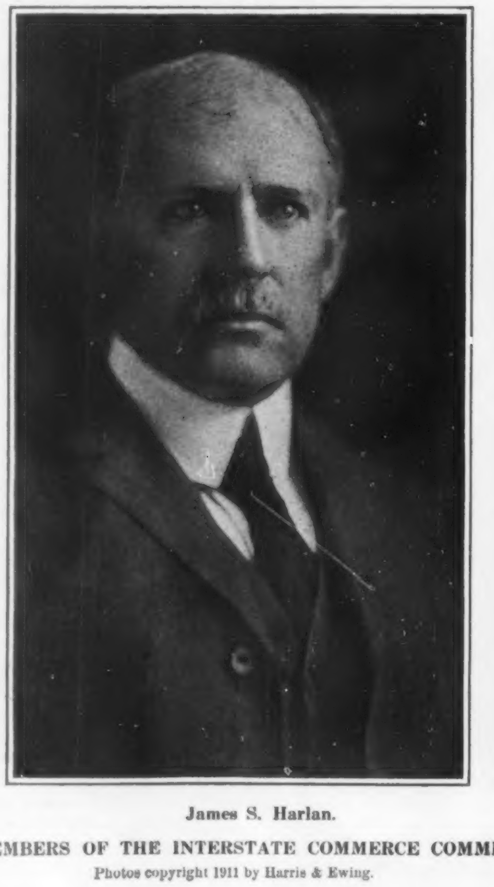
Merely to illustrate the growth of the work of the commission under the invigorated law, the following increases are significant:

There were filed with the commission from 1887 to 1906, 878 complaints, resulting in 393 reports or opinions, printed in eleven volumes of reports. Since the Hepburn act was passed 3,135 complaints have been filed, and 2,000 decisions, including unreported and memorandum opinions, have been rendered, filling nine volumes of printed reports. Many investigations have been undertaken both pursuant to resolutions of Congress and on the commission's own initiative. The records of the investigations in two of the latest proceedings, in the matter of rate advances under the act of 1910, printed under a Senate resolution, fills ten octavo volumes. Two hundred and thirty-nine criminal prosecutions have been instituted for violations of the act, and about three-quarters of a million dollars in fines have been collected from guilty shippers and carriers. Reparation aggregating over two million dollars has been ordered in formal contested cases and over one million dollars has been allowed upon the application of carriers on stipulated facts and suitable inquiry.

In the performance of its duty to prescribe the forms of tariff schedules and generally to enforce the provisions of the act, the commission has been under the constant necessity of interpreting not only the tariff schedules and specific items thereof but various provisions of the law itself in their application from day to day to specific shipments, as multitudinous

(Continued on page 607.)

Charles C. McChord.



James S. Harlan.

Balthasar H. Meyer.

THE MEMBERS OF THE INTERSTATE COMMERCE COMMISSION

# Relations of the Railroads to the Public—Co-operative, Not Antagonistic

By W. C. Brown, President New York Central & Hudson River Railroad Company

If there is compensation in all things there must be compensation even to the railroads in the running fire they have been under during this last generation and especially during the last six or seven years. It may be that the attention which has been given to their affairs will lead to their being so well understood both by railroad men and the people as a whole that discussion will come to rest upon mutually understood and agreed premises. That alone will be a considerable gain. Disputants never get anywhere unless they stand upon common ground. In all things the only common ground is fact, and in matters of nation-wide importance it is all the more necessary that discussion and action be based upon exact fact. The people need facts, the railroad men need facts, and the railroad men need to present facts to the people. During this generation of rapid railroad extension and tremendous increase in traffic, problems have arisen which the railroads have naturally looked at from one side and the people from the other. They have not always been thoroughly understood either by the railroads or the people. What both sides have needed is more light. When everybody has the facts there will be no chance for misstatement on either side.

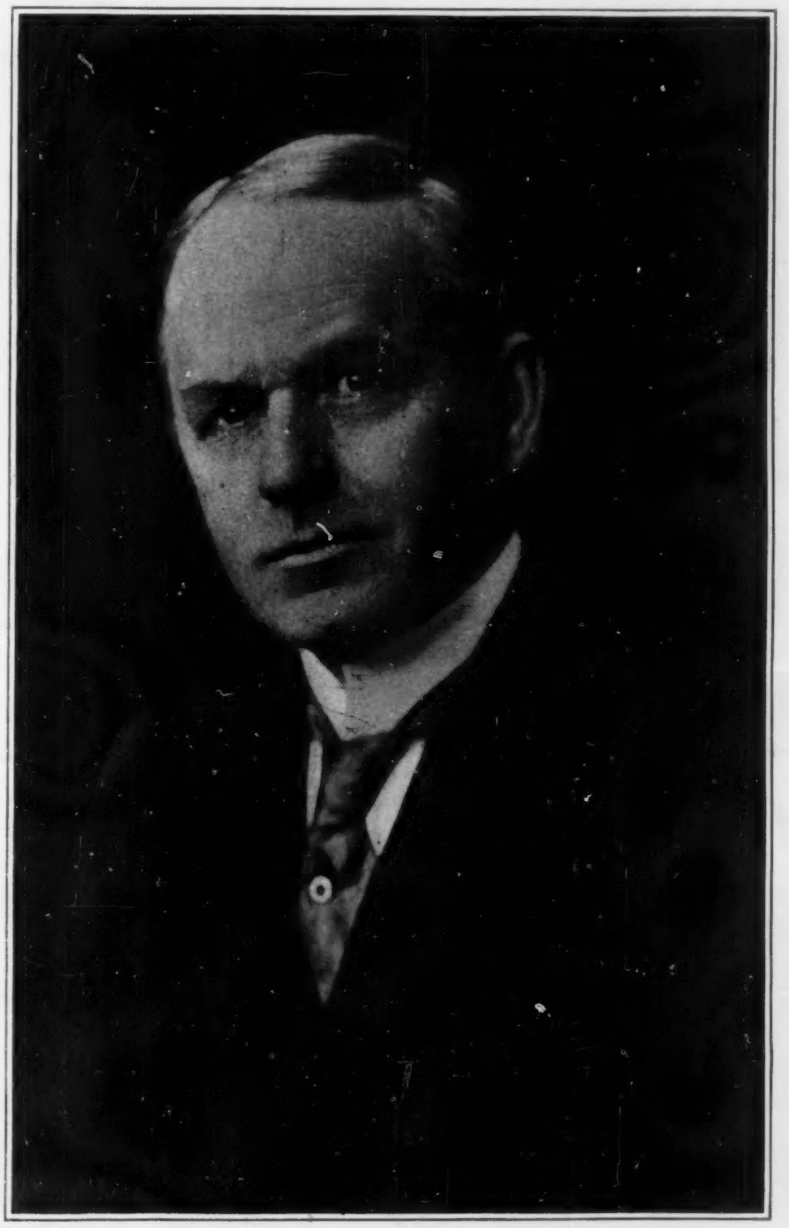
It is the simple truth that the railroads cannot succeed unless they serve the industry and commerce of this country satisfactorily in the present, and make proper provision for satisfactory service in the future. It is likewise the simple truth that the people of this country will not prosper unless they are willing to pay a fair rate for such services.

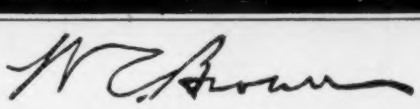
The first duty of a railroad is to carry passengers and property safely. The standard code of rules developed by the American Railway Association makes impossible a wreck or collision from any cause immediately connected with the moving of trains as long as those rules are observed. That these rules are not always observed is the fault of no one but the employee who is derelict. In all the laws that have been passed to compel the railroads to adopt this and that appliance, to shorten the hours of labor, or otherwise to favor the railway employee does anyone know of a single legislative enactment in this country which makes it criminal for a railway employee to carelessly disregard an order thereby jeopardizing the safety of lives or of property? As has recently been pointed out by Mr. Acworth, the discipline of railway employees is more difficult in this than in other countries because here one of these men when discharged can easily obtain another position, while in England, for example, it is an achievement to enter the railway service and a disaster to be discharged. If there is to be a diminution in railway accidents should not public opinion co-operate with the railway managers in enforcing discipline and obedience to rules?

To the safe and prompt carriage of freight is not only necessary the proper discipline of employees in its handling and loading, but careful packing and marking on the part of the consignor. If our shippers would always pay due attention to this they would not have so many damaged shipments and the loss and damage payments by the railways would be much less.

Every accident that results in loss of life or personal injury to passenger or employee not only entails expense which it is to the interest of a railroad company to avoid, but impairs its prestige. Every wreck or other accident that results in damage to property entrusted to its care is a source of greater expense and greater annoyance to the railroad company than to the shipper. It is likewise with delays in the passenger service or a freight blockade. In all of these respects the interests of the railroads are in no wise antagonistic to those of the public.

In his daily work the railway officer can never lose sight of the fact that co-operation with the public in the interest of the community at large is essential to the success of his company. To study, establish and maintain such co-operation is a large measure of his most serious work. In the broad sense that all the service rendered by a railroad company is public service, proper co-operation with the public is the serious thread that runs throughout all of his work. Some lines of activity may prosper in the face of general adversity. Their very opportunities may be found in adversity. The railroads, however, can prosper only when the community as a whole prospers, for business depression means the falling off of traffic. His duty to develop traffic moreover forbids the railway officer to meet antagonism with antagonism. Although communities as a whole, chambers of commerce and shippers' associations may vent bitterness upon his company, condemn his actions and impugn his motives, the railway manager is obliged to do the best he can in the way of conciliation and co-operation. Time was when the railway managers of this country were supposed to be continually on the aggressive in their dealings with the public. Whatever may have been the status during a past era they certainly have been on the defensive during these many years, and during these years have labored as never before to meet the desires of the public. The railway manager has become the patient servant of the people and has sometimes had cause to think that his master is fault-finding, overbearing and unreasonable. He is struggling in the hope of a better day.





President of the New York Central and Hudson River Railroad.

Not only is the prosperity of the railroad dependent upon the welfare of the community, but the welfare of every community is dependent upon the prosperity of the railroad. It cannot serve the community unless it is allowed that return which will enable it to pay wages, buy supplies, maintain its plant and equipment, and make improvements and extensions necessary for its future. This means that there must be due return to capital and prospect of return to the capital needed for the requirements of the future.

Every responsible citizen has not only an interest in the satisfactory operation of the railways that are now in existence, but he has an interest in the extension of railways throughout the regions that are not at this time adequately supplied. Notwithstanding the railway building of the past, there remain in the United States thousands and thousands of square miles of land that could be made productive if provided with adequate transportation facilities for its development. The land area of the United States comprises very nearly three million square miles. The region whose railways are designated by the Interstate Commerce Commission as Group No. 2 embraces practically all of New York, Pennsylvania and Maryland, all of New Jersey and Delaware, and a small portion of West Virginia, comprising 108,873 square miles, or only 3.5 per cent of the entire country. The census of 1910 shows that this area contains nearly 20,000,000 or a trifle less than 22 per cent of the 92,000,000 of our population. Yet, here in 1909 were 49,277 miles of *railroad track*, or 14.4 per cent of the total of 342,351 miles of track in the United States.

In extreme contrast with this is Group No. 10, composed of Washington, Oregon, Idaho, California, Nevada, Utah, Arizona, and a part of New Mexico. This group contains 759,409 square miles of land surface, or 25.6 per cent of the total area of the United States, but it had in 1909 only 27,053 miles, or but 7.9 per cent of all railroad track. In Group No. 2 there were 4.52 square miles of land for every mile of railroad operated, while in Group No. 10 there were 35.84 square miles.

These Western States can doubtless sustain a density of population equal to that of the North Atlantic seacoast, but that population cannot exist without railroads. Indeed, no such population can be attained unless the railroads extend as the population grows.

The farmers and merchants and manufacturers and every other class of the citizens of this country are intimately concerned with the extension of the railroads. Land increases in value as its products can be transported to markets, and when to an increasing number of homes are brought the conveniences that make life worth living. Manufacturers will

(*Continued on page 607.*)

# Transcontinental Railroads in the United States

## The Seven Great Systems Which Radiate from Chicago to the Pacific Coast

By William E. Hooper, Associate Editor, Railway Age Gazette

IF by the term "transcontinental railroad" one means a line from the Atlantic coast to the Pacific, then there is no transcontinental railroad in the United States, the only one in America in operation being the Canadian Pacific, mentioned elsewhere. Transcontinental, however, as applied to railroads, is generally understood to mean a road running from an eastern terminus, somewhere on the north and south line drawn from Chicago to New Orleans, to the Pacific coast. Because the traffic of the United States, both passenger and freight, has been built up in the way it has, there is very little, if any, advantage to be gained by the operation of a railroad from the Atlantic coast to the Pacific.

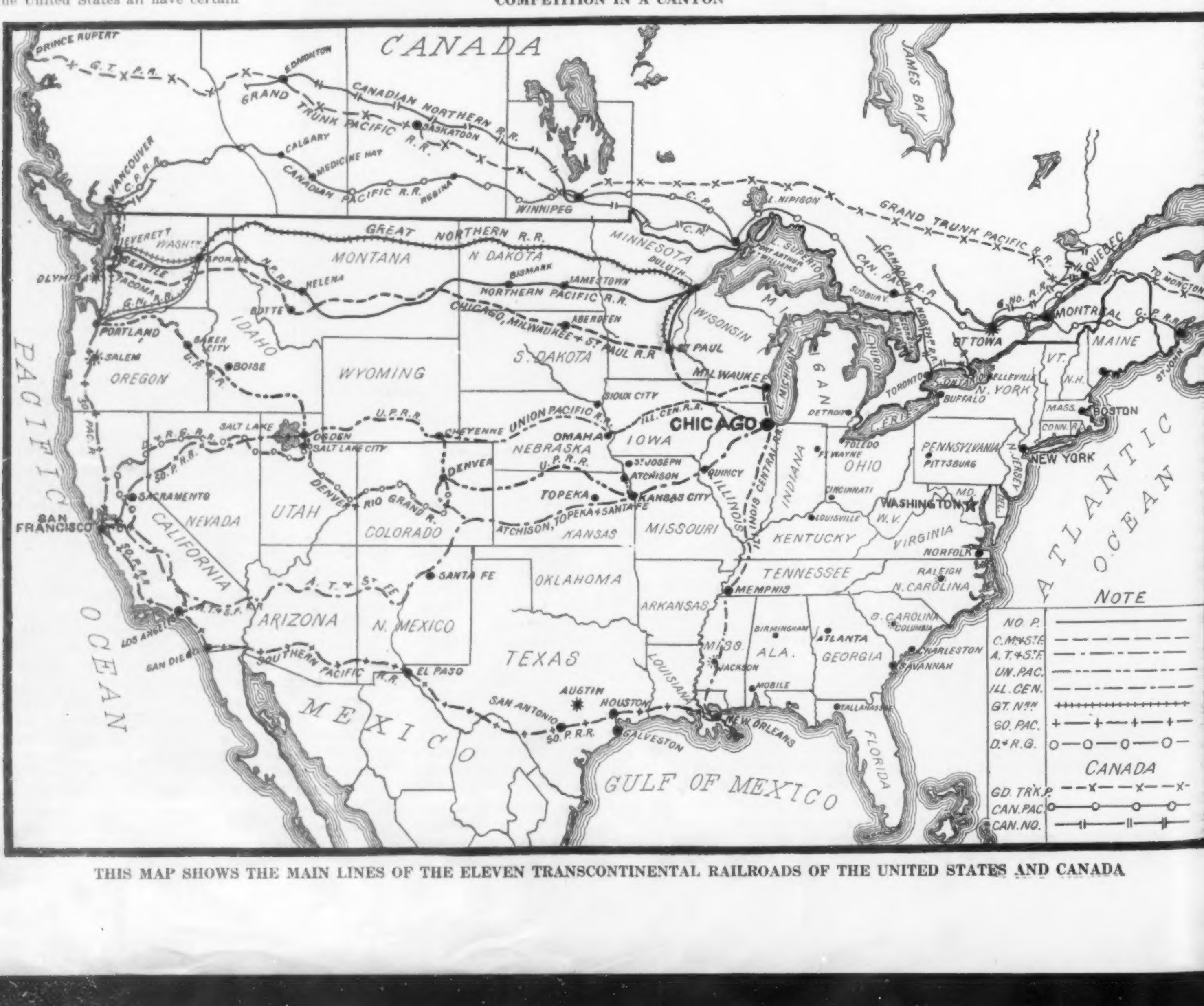
A practical traffic man will tell you that there is no advantage for a transcontinental road (meaning a road running from the Pacific coast to Chicago or St. Louis) to have an eastern connection of its own; in fact, he would probably tell you that such a connection would be a disadvantage, in so far as it would hamper a free bargaining on the part of the western road as between the different trunk lines in eastern territory. The accompanying map shows representative transcontinental roads, but no eastern connections are shown, because the map would not permit showing all of them, and it would be misleading to show only part of them.

The transcontinental roads in the United States all have certain characteristics in common. They all have to climb over the continental divide; they all have to cross long stretches of country which furnish little, if any, local traffic, and they all have to compete on through freight from the Atlantic seaboard to the Pacific coast with water-borne freight going from the eastern United States through the Straits of Magellan to the Pacific coast, or with freight that moves by water down the eastern coast of the United States to the narrow part of Mexico and crosses this strip of land by the Tehuantepec National Railway, and then moves again by water up the west coast. When the Panama canal is finished they will have to compete with a much shorter all-water route.

The first of the transcontinental railroads across the western deserts were built rather more for military and governmental reasons than through any hope of their immediately earning a sufficient amount to make the enormous investment in their construction profitable. Since private owners of capital were not inclined to be philanthropic, the government had to hold out inducements to them to invest their money by giving them land grants and making them loans. Of the seven roads shown on the map, five were extended to the Pacific coast by government help and the other two without. The writer has taken the Chicago, Milwaukee & St. Paul, with its subsidiary, the Chicago, Milwaukee & Puget

The horseshoe curve in the natural coliseum of the Deschutes River. On opposite banks are seen the two lines now being built by the Harriman and Hill systems.

COMPETITION IN A CANYON




THIS MAP SHOWS THE MAIN LINES OF THE ELEVEN TRANSCONTINENTAL RAILROADS OF THE UNITED STATES AND CANADA

Sound; the Northern Pacific; the Great Northern; the Union Pacific; the Denver & Rio Grande, with its subsidiary, the Western Pacific; the Atchison, Topeka & Santa Fé, and the Southern Pacific, as the more important transcontinentals. Of these the Denver & Rio Grande and the St. Paul were extended to the coast without government aid. In the accompanying table, in which certain rather interesting characteristics of each road are shown, the Denver & Rio Grande is omitted because it is impossible to give any figures for the newly constructed Western Pacific, and it would be quite misleading to give the Denver & Rio Grande's figures by themselves. The Denver & Rio Grande itself only runs from Denver, Col., and Pueblo, on the east, to Ogden, Utah, and Salt Lake City, on the west, with a great number of branches through Colorado. From Salt Lake City west the Goulds, using the Denver & Rio Grande credit, built a line paralleling in many places the Southern Pacific from Salt Lake City to San Francisco. It was built without any government aid, and built with modern standards and with modern standard grades; so that its actual initial cost was far higher than that of the other transcontinental roads. The other roads, with the exception of the St. Paul's Pacific coast extension, were built as cheaply as possible at first, and slowly, as the years have gone on and the freight traffic and passenger business has increased, the properties have been improved, rebuilt and often relocated, so that to all intents and purposes they are entirely different lines than those originally built.

Even with its Western Pacific, the Denver & Rio Grande would not be a transcontinental road if it were not for the fact that it is controlled by the Missouri Pacific as well as by the Goulds; and the Missouri Pacific, which is also controlled by the Goulds, runs from Denver and Pueblo east to Kansas City and St. Louis.

The Chicago, Milwaukee & St. Paul's Pacific coast extension is the other transcontinental that was built without government aid. The Chicago, Milwaukee & St. Paul Railway proper runs from Chicago and St. Paul to the Missouri River at Mobridge, S. D., with a mass of branch lines through Wisconsin, Minnesota, Iowa and South Dakota, and with a line extending as far as Rapid City, S. D., which takes it into the Black Hills. From Mobridge west through the southwestern corner of North Dakota, through the length of Montana and through the breadth of Washington, the St. Paul built a line to Tacoma and Seattle on Puget Sound.

The Chicago, Milwaukee & St. Paul is generally understood to be controlled by the Rockefeller and Standard Oil interests; the Missouri Pacific, Denver & Rio Grande and Western Pacific, as has already been mentioned, are controlled by the Goulds; the Great Northern and the Northern Pacific are both what are known as Hill lines, controlled largely by James J. Hill; the Union Pacific and the Southern Pacific are Harriman lines; and the Atchison, Topeka & Santa Fé, once controlled largely by the English banking house of Baring Brothers, is now not controlled by any one interest.

The competition between these seven roads, both for freight and passenger business, is very keen, and although it might seem surprising at first, the competition is nearly as keen between the Union Pacific and the Southern Pacific, for instance, which are controlled by the same financial interests, as it is between the

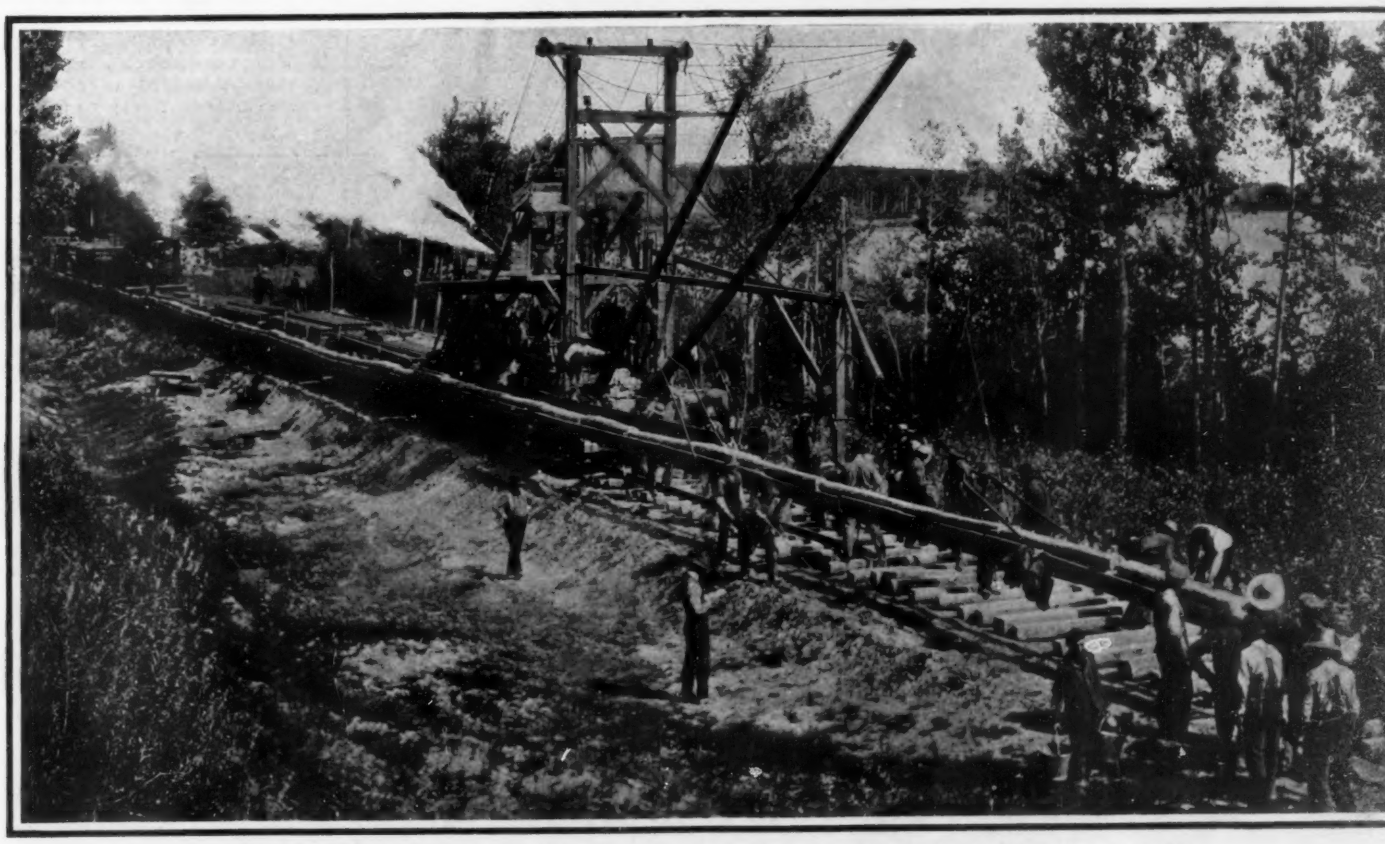
(Continued on page 598.)

**This type of bridge rendered possible the rapid construction of pioneer railroads in the western country where steel was costly and timber plentiful and cheap.**

HOWE TRUSS TIMBER BRIDGE ON THE PORTLAND & TILLAMOOK RAILWAY, OREGON

**Two competing railroads being built through the desolate Deschutes River Canon. On the right is Harriman's Deschutes Railroad; on the left Hill's Oregon Trunk Line.**

THE FIGHT FOR RAILROAD TERRITORY



**A track-laying machine which places ties and rails on the roadbed, advancing at the rate of four miles a day. The material is brought forward continuously from the loaded train in the rear and deposited in place.**

RAILWAY BUILDING UP TO DATE

# The Growth of American Locomotives and Railroads

## From the Baby 5-Ton Engine of 1832 to the 188-Ton Giant of To-day

By Herbert T. Walker

EIGHTY years ago there were 95 miles of railroads in operation in the United States. To-day there are over 242,478 miles, a length that if extended in a single line would encircle the earth more than nine times.

This enormous growth of our railroads has naturally been accompanied by the expansion or increase of size of the American locomotive; but with this difference, that while there is practically no limit to the extension of a line of railway, there is a well-defined limitation to the size of the engines, which must be kept within the measurements of the track and the height and width of bridges and other permanent structures. These rigid dimensions are known as the loading gage, and are substantially the same to-day as they were at the beginning of railroad history. Thus, the problem of designing engines to haul the constantly increasing weight of trains is one of exceeding difficulty, and its solution may be regarded as one of the greatest achievements of modern engineering.

In the year 1831, Matthew Baldwin, founder of the famous Baldwin Locomotive Works, received an order for a locomotive from the Philadelphia, Germantown & Norristown Railroad Company, whose short line of six miles was operated by horse-power. In designing the engine Baldwin was guided by the plans of the "Planet" engine designed by George and Robert Stephenson for the Liverpool & Manchester Railway in 1830. When completed the engine was chistened "Old Ironsides," and was tried on the road November 23rd, 1832. This engine is shown in the first figure of the accompanying illustration, which presents six American passenger locomotives drawn to a uniform scale for the purpose of comparison. "Old Ironsides" weighed something over 5 tons. The driving wheels were 4 feet 6 inches in diameter. The cylinders were 9½ inches diameter by 18 inches stroke. Its tractive effort was about 1,200 pounds. It attained a speed of 30 miles an hour with its usual train, but it only ran under favorable conditions, for in rainy weather the cars were drawn by horses.

During the next seven years great improvements were made in American locomotives, and the leading truck had come into use. A representative engine, built at the Rogers Locomotive Works, is shown in the second figure of our illustration. Engines of this class ran on the Jersey City & New Brunswick Railroad in 1839. The cylinders were 11 inches in diameter by 18 inches stroke. Driving wheels 4 feet 6 inches in diameter. Weight about 10 tons. Tractive effort about 2,000 pounds. The cylinders were inside the frame, and the valve gear, having the hook motion, was on the outside.

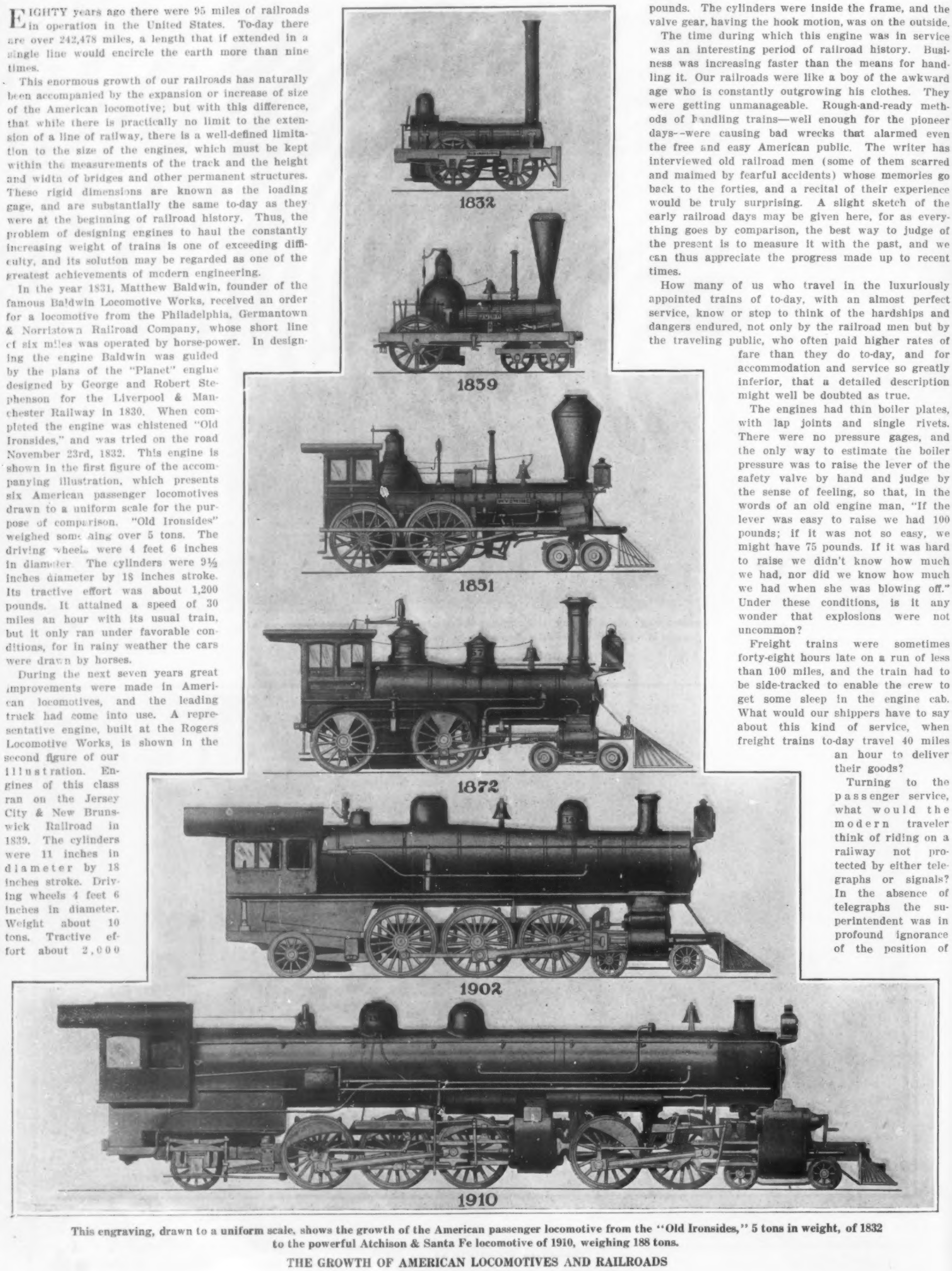
The time during which this engine was in service was an interesting period of railroad history. Business was increasing faster than the means for handling it. Our railroads were like a boy of the awkward age who is constantly outgrowing his clothes. They were getting unmanageable. Rough-and-ready methods of handling trains—well enough for the pioneer days—were causing bad wrecks that alarmed even the free and easy American public. The writer has interviewed old railroad men (some of them scarred and maimed by fearful accidents) whose memories go back to the forties, and a recital of their experience would be truly surprising. A slight sketch of the early railroad days may be given here, for as everything goes by comparison, the best way to judge of the present is to measure it with the past, and we can thus appreciate the progress made up to recent times.

How many of us who travel in the luxuriously appointed trains of to-day, with an almost perfect service, know or stop to think of the hardships and dangers endured, not only by the railroad men but by the traveling public, who often paid higher rates of fare than they do to-day, and for accommodation and service so greatly inferior, that a detailed description might well be doubted as true.

The engines had thin boiler plates, with lap joints and single rivets. There were no pressure gages, and the only way to estimate the boiler pressure was to raise the lever of the safety valve by hand and judge by the sense of feeling, so that, in the words of an old engine man, "If the lever was easy to raise we had 100 pounds; if it was not so easy, we might have 75 pounds. If it was hard to raise we didn't know how much we had, nor did we know how much we had when she was blowing off." Under these conditions, is it any wonder that explosions were not uncommon?

Freight trains were sometimes forty-eight hours late on a run of less than 100 miles, and the train had to be side-tracked to enable the crew to get some sleep in the engine cab. What would our shippers have to say about this kind of service, when freight trains to-day travel 40 miles an hour to deliver their goods?

Turning to the passenger service, what would the modern traveler think of riding on a railway not protected by either telegraphs or signals? In the absence of telegraphs the superintendent was in profound ignorance of the position of



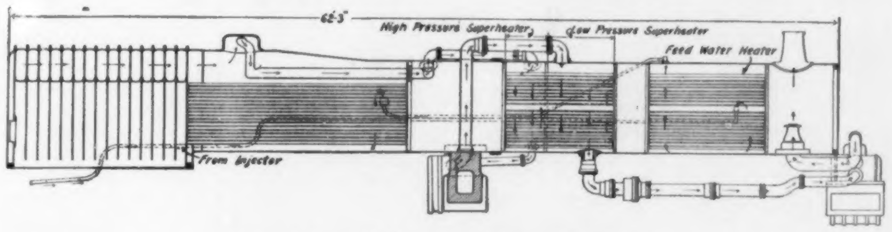

**This engraving, drawn to a uniform scale, shows the growth of the American passenger locomotive from the "Old Ironsides," 5 tons in weight, of 1832 to the powerful Atchison & Santa Fe locomotive of 1910, weighing 188 tons.**

THE GROWTH OF AMERICAN LOCOMOTIVES AND RAILROADS

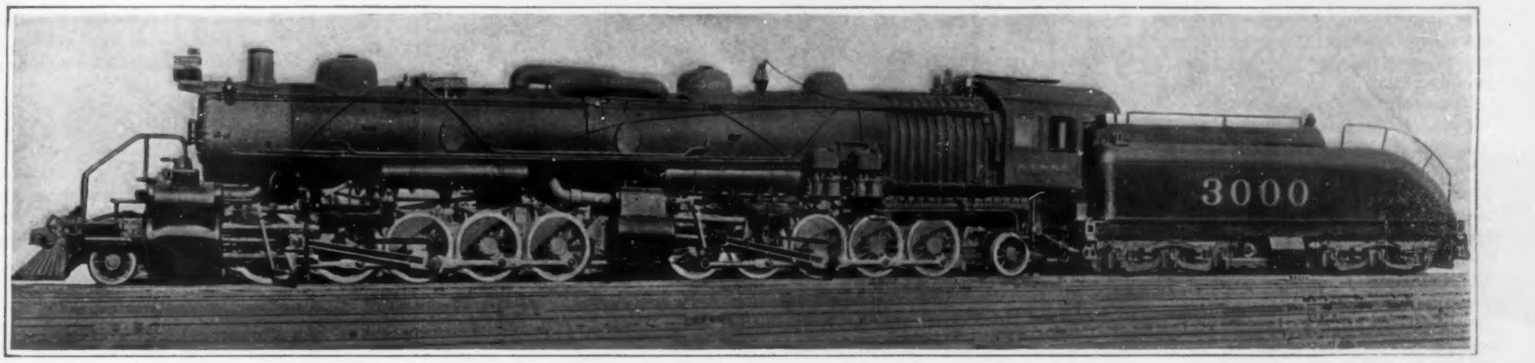
trains, and, in case of accident or delay, trains were "lost" and no man knew of their whereabouts. Sometimes men went on horseback to look for the missing train, but usually the superintendent sent a man out on an engine. This proceeding was attended with danger, as there was a chance of meeting the belated train head-on at some sharp curve. We may thus compare the conditions with those of our own day, when the train dispatcher knows the position of every train on his division, and, in some cases, can even communicate with the conductor of the train by telephone.

Lastly, we will take a look at the way our predecessors traveled on American railroads, by going back to the forties and imagining ourselves boarding the average passenger train on, we will say, a winter's night.

On entering the car, the first thing we see is the stove. It is of hideous design and is placed in the middle of the car. It burns wood, and for want of proper attention, sometimes gets red hot, to the insufferable annoyance of passengers unfortunately seated near it. The seats are narrow and otherwise uncomfortable. There is no law against spitting, and the filthy condition of the floor justifies the criticism found in Dickens's "American Notes" and "Martin Chuzzlewit." When the hour of departure has long passed we inquire the cause of delay and are pleasantly informed that the conductor and engineer are "bracing up" in the lunch room. At last a start is made, and when under way we find that we are going about fifteen miles an hour. Certainly not twenty. The track is not ballasted. The rails




**Sectional view of boiler, superheaters and feed-water heater as applied to "Santa Fe" Mallet locomotive.**




**This huge locomotive was enlarged at the Santa Fe shops from an existing locomotive by adding the superheater and feed-water heater sections. The engine weighs 308 tons, the tender 117 tons, making the total weight 425 tons. Its length over all is 120 feet 7⅛ inches. The H. P. cylinders are 28 inches dia.; the L. P. are 38 inches dia.; the common stroke is 32 inches. The max. drawbar pull is 111,000 pounds, and this locomotive has hauled 1,911 tons at 12 miles per hour over a 1.5 per cent grade. On the level it could haul a train so long that the side tracks could not take it in. At a speed of 10 miles per hour, estimated in the usual manner, it would develop about 3,000 horse-power, which at higher speeds, would be still greater. The fire-box has 204 square feet of heating surface, and the tubes 3,625 square feet. The gases next pass through the tubes of a superheater of 2,318.4 square feet surface and then through a feed-water heater of 2,659.5 square feet. The steam passes from the steam dome to the superheater; through the high-pressure cylinders; back to the low-pressure superheater; through the low-pressure cylinders, and to the exhaust stack.**

**SANTA FE MALLET FREIGHT LOCOMOTIVE, THE LARGEST IN EXISTENCE**

are either of strap iron, or if of the standard pattern, they are without fish plates, and the car lurches and bumps in a way that would be intolerable to the modern passenger. Anon, comes the conductor, swinging his lantern and collecting fares, as many or as few of which he will turn in to the company, as he pleases. In common with the brakemen, he wears no uniform. He is brusque, if not half way insolent to male passengers, but extremely polite to women. Some of these conductors hire negro lads to carry their lanterns. It is whispered that a few of them are richer than the president of the railroad. Illumination is by miserable oil lamps and reading is out of the question. We may beguile the tedium of the journey by looking out of window and watching the continuous shower of bright sparks drifting over the dark landscape. The locomotive burns wood and throws much fire. Dickens called this appearance "fiery snow."

But we are not sorry when the prolonged sound of the engine whistle gives the signal for "down brakes" and the brakeman hurries out to attend to his duties. The train comes to a gradual and long-drawn-out stop. Hand brakes are unreliable, and we probably over-run the station. Or perhaps this is a "depot" with neither platform nor lamps. Anyway, we shall be lucky if we escape landing in a gully or pool of water to the amusement of the grinning brakeman.

It is worthy of note that the public bore all the hardships of early traveling with far more patience than they do the comparatively slight inconveniences of to-day, and complaints were not usual.

The next example of a good passenger locomotive is presented is the third figure of the accompanying illustration. It was built at the Rogers Locomotive Works in 1851 for the Delaware, Lackawanna & Western Railroad. It was named "Wyoming" and was the first passenger engine for that line. The track gage was 6 feet. The cylinders were 16 inches diameter by 20 inches stroke. Diameter of driving wheels, 5 feet 6 inches. Weight, 28 tons. Tractive effort, about 7,500 pounds. This engine had the Stephenson link motion and was beautifully finished, the dome and safety valve casings, boiler bands, and wheel guards being lagged with polished brass, which gave the engine a handsome appearance. To-day, our engines are far less pleasing to the eye.

The next twenty years saw great changes in our railroads. The volume of business was increasing by leaps and bounds and the public were demanding faster trains. Here was, and is, the greatest source of anxiety to our motive power superintendents. The demand for higher speeds is always accompanied by a requisition for heavier trains, for high speeds cost money and it does not pay to run light fast trains. The locomotive engineer of forty years ago was ready to design powerful engines, but he was confronted by the difficulty of light rails. If he responded to the requirements of the transportation department he got into trouble with the maintenance of way department, for his engines would batter out the track. Some of the rails of seventy years ago were only 33 pounds to the yard and the heaviest was but 54 pounds. As late as the year 1851 rails in the eastern part of the United States weighed 56 pounds to the yard, laid on hemlock ties. No fish plates, but a cast-iron chair at each joint with an extra-heavy tie beneath it. In 1857 rails of 73 pounds were in use, but they were considered heavy.

In 1887 and subsequently, rails weighed from 75 to 80 pounds per yard. To-day rails of 100 pounds per yard are in general use.

As regards speeds, we find that in 1849 the average speed of passenger trains was 23 miles per hour. As late as 1864 the average speed of express trains was 32 miles per hour on a few of the most important lines. In 1889, 40 miles an hour was the average express speed. To-day speeds range from 50 to 60, but spurts of 80 and even 90 miles an hour are occasionally made.

A good example of a passenger engine for fast heavy trains of 1872 will be found in the fourth figure of our illustration. This was No. 573, built for the Pennsylvania Railroad at the Altoona shops. This engine burned bituminous coal and its chief dimensions were: Cylinders, 17 inches diameter by 24 inches stroke; diameter of driving wheels, 5 feet 2 inches; weight, about 37 tons; total heating surface, 1,056.98 square feet; boiler pressure, 125 pounds; tractive effort, about 1,100 pounds. This style of engine was the standard locomotive for many years.

About twenty-nine years ago six-wheels-coupled engines for heavy passenger service came into the field and some of the highest speeds were attained by these engines. In the year 1902 a still heavier passenger engine was introduced having a pair of trailing wheels behind the drivers. A side elevation of this engine is shown in the fifth figure of our illustration and its length of 48½ feet, when compared with the previous engine, is strikingly apparent. This engine was built for the Chesapeake & Ohio Railroad by the American Locomotive Company at their Schenectady works. The cylinders are 22 inches diameter by 28 inches stroke. Driving wheels, 6 feet in diameter. Steam pressure, 200 pounds. Total heating surface, 3,533.28 square feet. Tractive effort, 32,000 pounds. Weight, 95 tons.

During recent years the weight of passenger trains has so greatly increased as to necessitate a radical departure in locomotive design. In 1856 a passenger coach weighed about 25 tons. In 1872-5 the weight had crept up to 28 or 30 tons. To-day a parlor car weighs about 60 tons, and our passenger trains frequently weigh 400 tons behind the tender. As the loading gage limit was reached years ago, the only way in which the dimensions of a locomotive can be expanded is in the direction of its length. This was first done about the year 1888 by M. Anatole Mallet, a French engineer who introduced his "articulated" locomotive; but the latest development of this class of engine for passenger service is shown in the last figure of the illustration. This engine was built in 1910 by the Baldwin Locomotive Works for the Atchison, Topeka & Santa Fé Railway. The length of this mammoth locomotive is 69 feet 6 inches. The boiler with its superheater and feed-water heater is connected rigidly to the frame in which are carried a pair of trailing wheels, the six-coupled drivers and the high-pressure cylinders. The low-pressure cylinders, four-coupled drivers, and leading truck are carried in the separate frame, to provide for lateral movement as the locomotive enters a curve. A full description of this engine appeared in the SCIENTIFIC AMERICAN of January 29th, 1910, but the leading dimensions may be repeated here: Diameter of high-pressure cylinders, 24 inches by 28 inches stroke; diameter of low-pressure cylinders, 38 inches by 28 inches stroke; driving wheels, 6 feet 1 inch diameter; heating surface, 4,756 square feet; superheating and re-heating surface, 1,121 square feet; steam pressure, 200 pounds; weight of engine, 188 tons; tractive effort, 58,000 pounds, sufficient to lift as a dead weight a passenger engine of thirty-five years ago. This engine is equal to the power of two ordinary locomotives, and hauls trains over the heaviest mountain division of the line.

In conclusion the writer takes pleasure in thanking the Baldwin Locomotive Works, the American Locomotive Company, and Mr. C. H. Caruthers of Yeadon, Pa., for the use of data embodied in the foregoing article.

**A Moving Land.**—One of the broad slopes of Mont Gringuez, France, is reported to have become detached from its foundations, and to have moved over a distance of nearly a quarter of a mile, carrying with it the soil, meadows and woods, and covering up in its passage roads and bridges that stood in the way. A chestnut grove has traveled 500 feet without suffering any apparent damage, but many small lakes have been formed by the damming of the waters.

# The Transcontinental Railroads of Canada

## How the Government and the Railroads are Co-operating in Building Up the Great Northwest

By J. W. Whitman

THE three transcontinental railroads of Canada are distinguished from those of the United States by the fact that they extend, or will do upon their completion, entirely across the country from the Atlantic to the Pacific, with terminal ports on each ocean. Of the three whose main lines are shown upon the railroad map published on page 588, the Canadian Pacific is completed, and the Canadian Northern and Grand Trunk Pacific are under construction and both slated for completion in the year 1914.

**Canadian Pacific Railway.**

The charter granted by the Canadian government to the Canadian Pacific Railroad, February 18th, 1881, prescribed that the road should be carried through to the coast in ten years' time. From the government, by way of encouragement, the company received $25,000,000 in cash, 25,000,000 acres of land fit for settlement, and 713 miles of railroad in which were included two of the most difficult sections. At that time the great northwestern section of Canada had been favored with little or no settlement. Transportation facilities to aid in construction work were not available, and the building of the line to the coast called for pioneer engineering of the most strenuous character. In spite of these difficulties, however, the road was finished in five years' time—a feat which will ever redound greatly to the managerial and engineering ability of the Canadians.

The opening of the new road was followed first by a gradual, and in later years by a phenomenally active settlement of the country, which was promoted by the joint activity of the railroad and the government. The fertile wheat lands of the prairies were thrown open to settlement upon liberal terms, while in later years the certainty of remunerative crops was assured by the construction of some of the largest irrigation works in the world.

The story of the growth of the Canadian Pacific Railroad to its present commanding position has been due to the broad view which the company has taken of its opportunities, and to the realization of the fact that its system of lines, stretching from ocean to ocean, in addition to performing its great work of opening up new country and developing industries and promoting commerce, could also be made to form the central link in a continuous system of transportation reaching from the Occident to the Orient. In due course lines of steamers were placed upon both oceans, and the activities of the company on land, lake and sea have grown to an extent which can be judged from the following facts: To-day the company own and control some 16,000 miles of railway, 11,500 miles of which form the Canadian Pacific Railway proper. It employs 76,000 people, all on the pension system, among whom are distributed every month some $3,800,000 in salaries and wages. The company owns its own sleeping, dining and parlor cars, its own telegraph system, and its own express company, and the total value of its railway and equipment is $317,000,000. Including its service on ocean, lakes and river, it possesses a fleet of sixty-seven steamships, sixteen in commission and four building on the Atlantic, four in commission on the Pacific, twenty in the British Columbia coast service, and the balance on the Great Lakes and inland waters. Also it owns a chain of sixteen hotels, built originally to provide for the efficiency of the system, and now all are on a paying basis.

**Characteristic rock fill across a creek.**

The story of the settlement of the country can be largely told in terms of its land operation, which forms a most interesting record. Of the original grant of 25,000,000 acres the company still has in western Canada 8,000,000, and in British Columbia 4,500,000 acres, now valued at $180,000,000. The early sales in 1883 of the most desirable agricultural land in Manitoba were made at an average price of $2.85 per acre. In 1910, so greatly had values appreciated under the improvements due to larger railway facilities and constant settlement, that one million acres were sold at an average price of $14.80 per acre. To-day, in the Bow River Valley, one of the biggest schemes of irrigation outside of India and Egypt is being carried out, involving three million acres of land. The first operation covered 400,000 acres, and required 1,580 miles of ditches and canals, and all of this section has been sold. Work is now being done on an additional 500,000 acres, to be followed by extensions to an additional 200,000 acres.

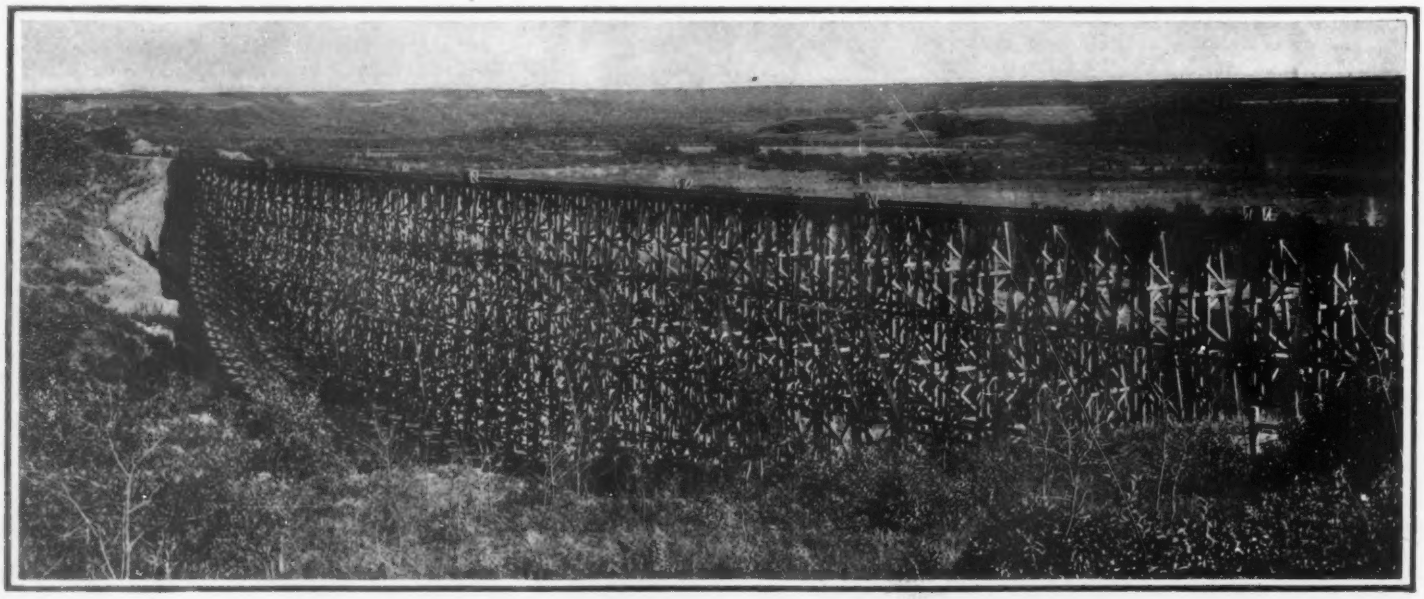
Within the limits of the present article it is impossible to enter any further into details; but mention should be made of the celebrated Angus shops, which are capable of turning out a complete train every day for the service of the road, which, as we have said, owns its own sleeping, dining and parlor cars. So great has been the immigration into the Northwest, particularly of energetic and thriving farmers from the United States, that the company at the present time is building betwen 500 and 700 miles of new railway each year in the endeavor to keep up with the development of the northwestern country.

**The Canadian Northern Railway.**

It was less than fifteen years ago, in December of 1896, that the first train to earn revenue for the Lake Manitoba and Canal Railway Company—the nucleus from which has sprung the present Canadian Northern Railway system—left Gladstone, Manitoba on its one hundred mile trip to Dauphin. The gross revenue from the hundred miles operated the first year was $60,000; thirteen men and a boy constituted the staff, and the payroll was $650 per month. Within less than fifteen years the gross revenue of the Canadian Northern and its allied railways has grown to over $18,000,000, its staff has increased to 48,400, and to-day the railways of the Canadian Northern system are running in six provinces with a mileage which has grown at the rate of a mile a day for fourteen years. Farmers of the prairie provinces have over 3,500 miles of road at their service, and a glance at our railroad map on page 588 of the present issue will show that it needs only the completion of connecting links which are being built between Lake Superior and the Ottawa Valley and between Edmonton and the Pacific Coast to make of this system a transcontinental railway, with a widely-diverging and comprehensive system of branch roads.

The expansion of the Canadian Northern in the wheat-growing belt is being carried out upon a plan which will result in the possession of five principal lines running east and west with certain northwesterly developments which will make the system as serviceable to the Hudson Bay bread route to Europe as it is to the present route by way of Lake Superior and the St. Lawrence. One thousand miles from Lake Superior the company is opening up vast areas of wheat land, as fertile and more extensive than those which have assured to Manitoba and south Saskaychewan their great reputation as wheat-producing districts. Southwest of Saskatchewan the line is being built across the fertile Saskatchewan plain. From the first seventy-six miles of line in this district there was hauled in 1909 2,000,000 bushels of wheat to Port Arthur, and in addition to the wheat business there are vast timber tracts to the east and northwest of Prince Albert, which the new road has brought into touch with the commercial world.

The expansion of the Canadian Northern from Alberta to the Pacific Coast was assisted by the guar-



**Many miles of lofty timber trestles were built to carry the grade of the Grand Trunk Pacific across the depressions. These will ultimately be filled in, making solid embankments.**

**THE TRANSCONTINENTAL RAILROADS OF CANADA**

anteeing of the bonds of construction up to $35,000 per mile by the British Columbia government. It is a distinctive feature of this system that it has been produced from within the prairie provinces, and the earning power which it had displayed assisted greatly in securing government support, which was formally assured by an act passed in 1910, and was speedily followed by the commencement of construction eastward from the mouth of the Fraser River at New Westminster. The main line from Edmonton is advancing to meet the British Columbia section by way of Lac Ste. Anne and the McLeod River. Hence, as provided in the statute, British Columbia will receive its first competitive communication with the prairie provinces during the year 1914. The main line will ascend the Fraser River Canyon and will surmount the summit on its way to Edmonton by way of the Yellowhead Pass, which is claimed to be the easiest summit of any pass through the Rocky Mountains. The road will afford connection between Puget Sound and Duluth within a mileage almost the same as that of the Northern Pacific, the pioneer railway across the northwest States; but it will have the advantage that its trains have to be hauled over only one summit, and that of the low elevation of 3,700 feet.

During 1910 the new terminal passenger station was completed at Winnepeg, for the joint occupation of the Canadian Northern, the National Transcontinental and the Grand Trunk Pacific Railway.

Contemporaneously with this development in the western provinces the company is actively prosecuting the work of joining up certain separately-operated lines in the eastern provinces; and when this has been completed the system will have a complete transcontinental road from Quebec to the Pacific Coast. The chief of these eastern roads is the Canadian Northern Ontario Railway in connection with which the company is building a new line between Toronto and Ottawa, which is about completed. It is also engaged on the construction of a line west of Toronto toward Buffalo. During 1909 Ottawa was connected with Montreal and Quebec by a section of the Canadian Northern Ontario Railroad, which by connecting with the Canadian Northern Quebec gives to Quebec its shortest route to Ottawa and a competitive line between Quebec and Montreal north of the St. Lawrence.

For eight months in the year the freight business between East and West mainly goes by the great lakes. By its control of a fleet of lake steamers, the Canadian Northern is, therefore, able to handle freight from tide-water to Edmonton for about eight months in the year. It is necessary to supplement this by an all-rail route, for which purpose the gap between Cowganda Junction and Port Arthur, roughly 450 miles, must be filled, and eventually a short line to obviate the necessity of hauling freight from Montreal to the West by way of Toronto. This will be accomplished by connecting Ottawa with the Toronto-Sudbury line at or near Key Junction, so as to give rapid connection with Key Harbor. For the Cowganda-Port Arthur gap, the Ontario government has proferred a land grant of 4,000 acres per mile, and it is anticipated that the completion of this line will synchronize with the completion of the line through British Columbia, which is guaranteed for 1914.

The year 1910 is notable not only for the advent of the Canadian Northern at the Pacific Coast, but for its appearance among Atlantic passenger fleets. In May the Royal Line of the Canadian Northern system began a fortnightly service between Bristol and Montreal, with the "Royal Edward" and "Royal George," the two fastest as well as the most splendidly equipped steamers in the Canadian trade, which gave Bristol its first up-to-date passenger service with Canada.

Closely massed and mutually protected from storms, the magnificent timber of the Northwest grows straight as an arrow and free from knots to heights of 250 to 350 feet.

Marion Lake near Glacier, B. C., a typical lake and mountain view on the line of the Canadian Pacific Railway.

THE TRANSCONTINENTAL RAILROADS OF CANADA

**The Grand Trunk Pacific Railway.**

The third and latest of the Canadian Transcontinental railways, the Grand Trunk Pacific, has the unique distinction of being the only road ever planned and built as a definite transcontinental line, reaching from the Atlantic to the Pacific. Also it is the greatest length of railroad that has ever been conceived and put under construction in one complete scheme, since it is 3,556 miles from terminus to terminus. It is the first line to be thrown across the North American continent from ocean to ocean under one management, thereby being a transcontinental railway in the fullest sense of the word; it crosses the mountains at a lower maximum altitude than any competing line; it has been built at a more northerly latitude than was conceived possible a quarter of a century ago, the route laying for the greater part of its length between the 48th and 54th parallels, and it has easier grades and curves than any line on the continent.

(Continued on page 608.)

# The World's Greatest Railway Terminal

## How the New Grand Central Station Will Handle, if Need be, Two Hundred Trains an Hour

By Walter Bernard

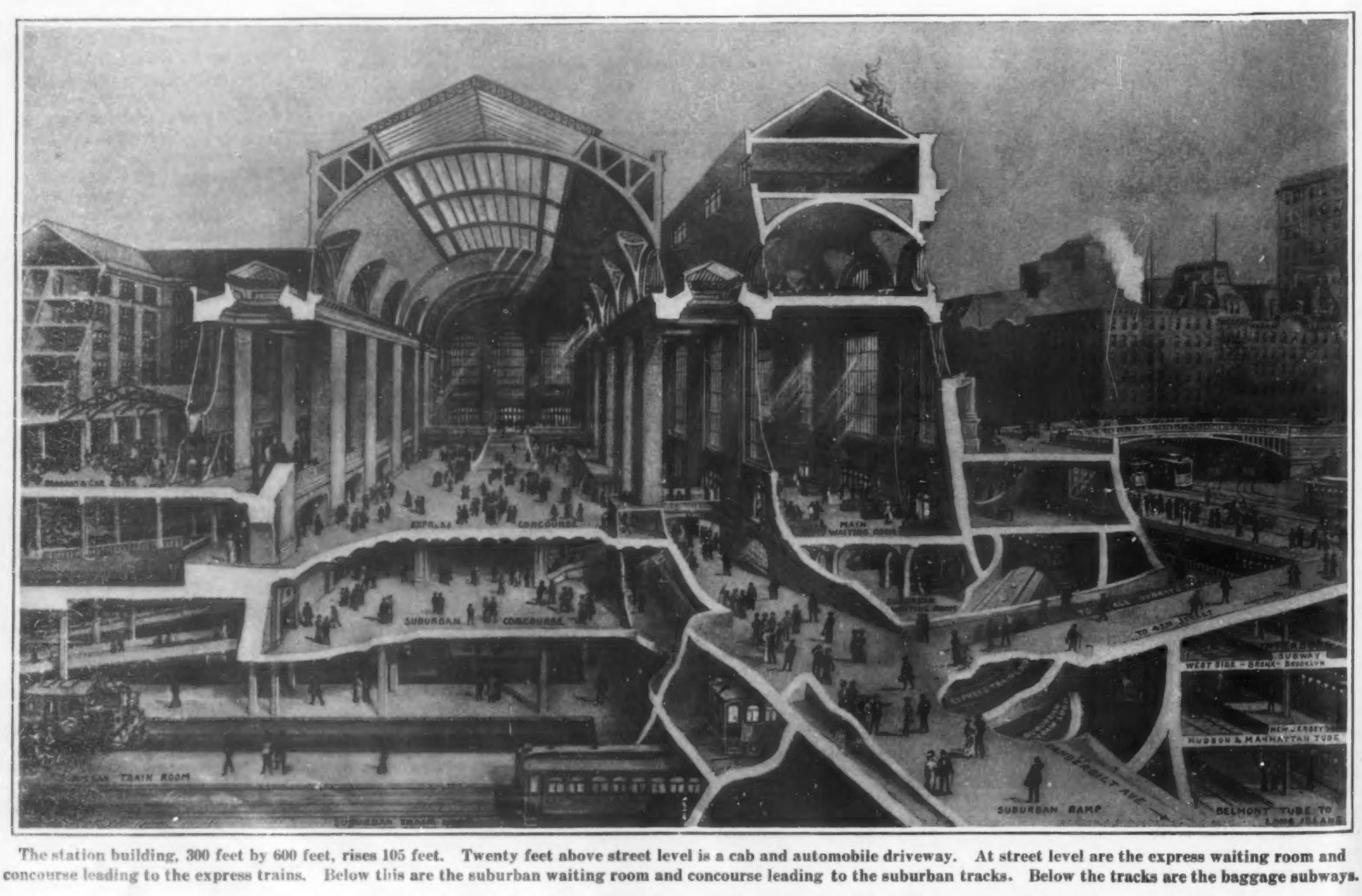
A DOZEN years ago the problem of handling the ever-increasing multitude which flowed into and out of the terminal stations of our leading railroads was causing great anxiety to the engineering and operating departments, whose duty it is to look far ahead and provide for future developments. Particularly was this true of the Grand Central Station, New York, which forms the eastern terminus of the vast system of railroads which is owned and operated by the New York Central and Hudson River Railroad Company. The old station, built in the seventies, with an annual capacity for handling twenty-one million passengers, was considered to be far in advance of its time, and sufficient to take care of a century's growth in the business of the company. Thirty years after its date of opening, however, the company realized that traffic was advancing so rapidly that within a few years' time the Grand Central Station, in spite of its dimensions, would soon be swamped by the swiftly-rising tide of travel.

The company, however, was confronted by two serious limitations, each of which presented an effective barrier against any great extension of the terminal facilities. On the one hand, the station, being located in the heart of the city, was surrounded by property whose value was so high that any adequate purchase of real estate for the purpose of extending the area of the station at street level was out of the question; and on the other hand, the flow of traffic to and from the enlarged station would be throttled by the limited capacity of the four-track tunnel under Park Avenue.

Easterly facade of the new terminal building, showing Lexington Avenue as it will appear when the whole station yard area has been built over.

Electricity, which has solved so many a problem in modern engineering, proved to be the perfect solution of this riddle. The electric motor, silent and smokeless, enabled the railroad man to get rid at once of poisonous gases and the roar of the locomotive exhaust. No longer was it necessary, for purposes of ventilation, to build the new station at street level and open to the atmosphere. Trains could be sent through the Park Avenue tunnel without vitiating its atmosphere, and the great terminal station could be sunk below ground, the street level restored above it, and the whole area of the station yard covered with the residential and commercial buildings of a modern city.

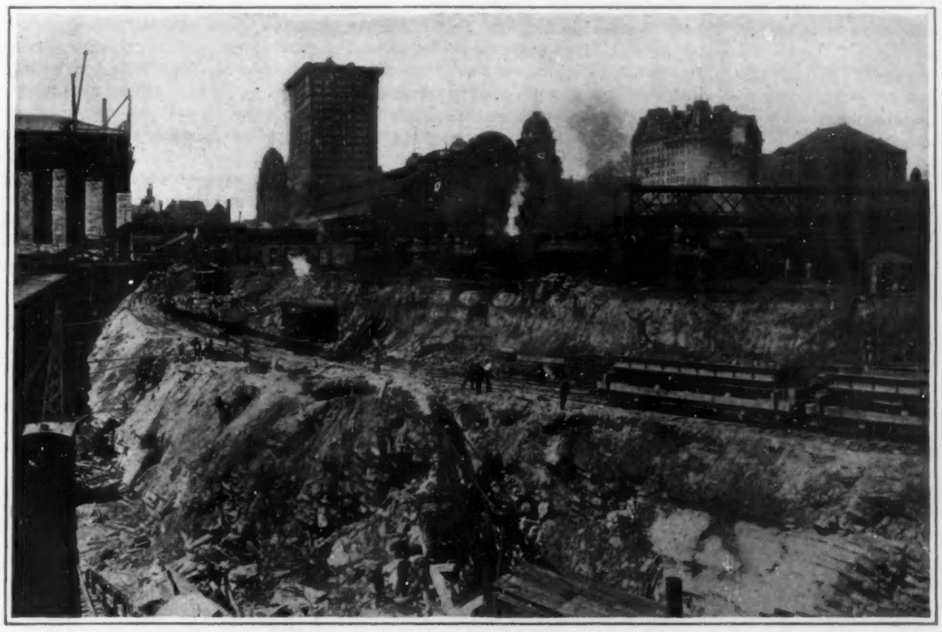
And so the New York Central Company, acting upon the opportunity presented by the development of electrical traction, made large purchases of real estate, contiguous to the old station yard, and proceeded to prepare for the new terminal by making a vast excavation 45 feet in depth and 46.2 acres in extent on the site of the old station yard. Even the 46.2 acres did not provide sufficient




The station building, 300 feet by 600 feet, rises 105 feet. Twenty feet above street level is a cab and automobile driveway. At street level are the express waiting room and concourse leading to the express trains. Below this are the suburban waiting room and concourse leading to the suburban tracks. Below the tracks are the baggage subways.

SECTIONAL VIEW OF THE NEW GRAND CENTRAL STATION AND THE ADJOINING SUBWAYS

area to accommodate the 31.8 miles of terminal trackage, and therefore the station was planned to cover two decks or levels, with a total area of 69.8 acres, the lower level to be devoted to suburban traffic, the upper to the express long-distance service. The plan called for the removal of the old station, with its steel and glass roof, and the substitution of a new terminal which should not only be able to accommodate, if need be, some 30,000 people, but should also provide office room for the thousands of employees necessary to carry on the engineering, administrative, and clerical work of the company.



**To the left are the new office building and the excavation for the tracks. To the right is the old train shed, now removed, and a part of the express traffic using the old high level.**

**NEW STATION EXCAVATION LOOKING SOUTH**

The construction of the station was enormously complicated by the fact that it was necessary to keep the whole machinery of the terminal in continuous operation during the building of the new work; and it is safe to say that the most creditable fact connected with this stupendous work is that it has been carried through simultaneously with the operation of the trains, which, except for some inevitable confusion when electrical service was first instituted, has continued without serious interruption night and day.

The plan of construction was to commence excavation at the easterly, or Lexington Avenue side, and as fast as the work was carried down to grade, to erect upon it the steel work for the two new levels, lay the tracks upon it, and transfer the trains gradually from the old to the new levels. This plan has been followed with great success; and a few months ago the last of the express trains, after it had cleared the Park Avenue tunnel entrance, swung over on to the upper deck of the new steel structure, and the demolition of the old station building was begun, followed by the blasting out of the last section of the rock excavation. In a few weeks' time the excavation will be completed and the last car load of the three million cubic yards of rock will have been hauled through the Park Avenue tunnel and dumped on the river side of the New York Central Railroad tracks, where they skirt the Hudson River far to the north of the city.

Comparative Statement—Principal Passenger Stations in the United States and Europe.

| | Total Area, Acres. | Length Track, Miles. | Number of Tracks | Number of Platforms. |
|---|---|---|---|---|
| New Grand Central Terminal | 69.8 | 31.8 | 46* | 30 |
| Pennsylvania, New York City | 28.0 | 16.0 | 21 | 11 |
| Chicago & Northwestern, Chicago. | 8.0 | 2.7 | 16 | 8 |
| St. Louis Union Station | 10.9 | 5.4 | 32 | 16 |
| Boston South Station | 9.2 | 15.0 | 32 | 19 |
| Washington Union Station | 13.0 | ... | 29 | 13 |
| Cologne | 5.8 | 3.4 | 14 | 9 |
| London Waterloo Station | 8.75 | .... | 18 | .... |
| Dresden Main Station | 7.0 | 3.0 | 14 | 8 |
| Paris St. Lazare | 11.2 | 3.5 | 31 | 14 |
| Frankfort, Main Station. | 11.0 | .... | 18 | 9 |

* Of the total 67 tracks these 46 have platforms.

Architecturally and æsthetically, New York city will be greatly advantaged by the construction of the new station. In the first place, all the crosstown streets, from Forty-fifth to Fifty-sixth, inclusive, will be carried at grade entirely across the station yard, intersecting Park Avenue, which will also be extended at grade from Fifty-seventh Street down to Forty-fifth Street, on the south side of which will be the north façade of the new station structure. From this point the traffic will pass around the station on a broad elevated driveway to Forty-second Street, which it will cross on a bridge of handsome design, continuing at grade till it joins the present high level of Park Avenue at Fortieth Street. This broad, rectangular driveway, standing at a considerable elevation above Forty-second Street, Vanderbilt Avenue and Depew Place, will form, as it were, a broad, elevated base, from which the huge station building will rise with a fine monumental effect.

By referring to our front page engraving it will be seen that, for the present, the station yard tracks will be exposed to view in the area north of the station; but ultimately these areas will be covered by buildings designed to present a monumental effect, in which will be included museums, hotels, business blocks, and theaters. These buildings will either be erected by the railroad company and leased, or they will be put up by private enterprise. In the latter case the railroad company will reserve the right to exercise a strict supervision over the architectural features of the buildings, which probably will be classical or semi-classical in treatment. Ultimately, the whole space will be covered in, and on the site of the old and unsightly yard, with its smoke and dirt and noise, there will rise a new section of the city which, in the dignity and harmony of its architecture, will be unequaled in any part of the greater city. It is interesting to record that the rentals from these buildings will be sufficient to cover the interest on the vast expenditure involved in the construction of the new station.

The new terminal will have four levels, where the old had but one at street level. At the grade of Forty-second Street will be the gallery; below that will be the great concourse on the level of the forty-two tracks that will handle the through express trains. On the third level will be the twenty-five tracks for the suburban trains; and below these, running east and west under Forty-third and Forty-fifth Streets, will be subways for handling the inbound and outbound baggage.

An important problem in building the terminal station is to separate the inbound from the outbound traffic, so that passengers and their baggage may flow in an unbroken stream from street to train or from train to street. To secure this unobstructed flow has been the governing motive in designing this station, and an important element in the plan has been the total elimination of stairways and the substitution therefor of inclined passenger walks, or, as they are technically known, "ramps," which will be constructed on a grade of eight feet rise to every hundred feet of length. With a view to avoiding congestion, no less than twelve separate entrances to the station are provided. The passenger purchases his ticket in the express concourse, and passing to the next counter, turns over his ticket and baggage checks to the transfer company, who send them by pneumatic tube to the baggage room, where the trunks are checked, and the trunk checks sent back. Passing through the gates on the side of the concourse opposite the ticket offices, the passenger walks down an easy incline to the express passenger platforms, which are at the same level as the floor of the cars, and boards his train.

The handling of baggage into and out of the trains is entirely separated from the passengers, the incoming baggage being unloaded beyond where the passengers leave the train, and the outgoing baggage being brought up to the baggage cars, at the front of the trains, from the subways already referred to.

**It has been necessary to remove 3,000,000 cubic yards of rock in sinking the tracks to the new level, 45 feet below the streets. To the right is the steel work for carrying the two levels of tracks for express and local trains.**

**VIEW OF EXCAVATION LOOKING NORTH**

Following out the principle of segregation of classes of passengers, there will be two large waiting rooms adjoining the Forty-second Street entrances, one for through long-distance passengers, and another immediately below it for suburban service, each being on the level of the tracks which it serves. Everything, ticket offices, entrances and exits for the express and suburban service, will be entirely distinct and separate, each having its own concourse, its own information bureau, baggage checking places, parcel room, and other facilities for travel. The concourse for inbound trains can comfortably hold 8,000 people, that for outbound trains, 15,000. The waiting rooms will accommodate about 5,000 more, and altogether this great station can take care of nearly 30,000 people without subjecting them to uncomfortable crowding. It

(Continued on page 609.)

# A Substitute for the Rate Increase

## Economics of Scientific Management as Applied to the Railroads

By Charles B. Brewer

NOW that the railroads cannot increase their revenue by raising rates, it behooves them to look in other directions.

Much has been said and written about the high cost of living. Results may be looked for when more attention has been paid to what somebody has aptly expressed as the "cost of high living."

The bugle call was sounded when Mr. Brandies, the Boston lawyer, gave such wide publicity through the railway rate hearings to the movement of conservation of human effort practiced for some years by a few advanced engineers and manufacturers.

This movement, known as scientific management, has as its foundation stone a measurement of output. No great advance is probable in any line unless it be known beforehand exactly what *has* been done in this line—in order to know what it is we are striving to improve on. Thus, as the trotting record has been lowered materially by using selected pacemakers, it will be possible to accomplish results in matters industrial when we have sufficient knowledge to select the pacemakers for each particular branch.

Nothing stands in the way of selecting industrial pacemakers as does the cloak of secrecy thrown around the accounting departments. In this connection I often recall a remark made to me a good many years ago by a companion in the engineering office of one of the large steel plants. He was a Norwegian, only a few months in this country, and had come to our office from the engineering department of one of the great trunk lines. A habit of prying around rival shops possessed him. "A Yankee" said he "will tell anything and everything about his business so long as he can make it appear he knows more of the subject than you." This remark would, in all probability, have been modified had my friend's experience included quizzing of the "Yankees" about the *cost* of their work.

Only a few days since I was shown a newly written letter from the vice-president and general manager of one of the big railroads in answer to that of an acquaintance who had had the temerity to ask for cost figures from this manager's shops. As should have been expected, the reply did not give the information. In conclusion, the refusal recited how impossible compliance was—that such figures were *never* given to one outside the company, etc.

This secrecy as to cost accounts prevails in every branch of the industrial world. It is considered almost a breach of etiquette to mention the subject to one who may in any manner be considered a rival. The manufacturer, otherwise liberal in giving out information as to methods, thus locks from others and has others lock from him the door through which might pass illuminative information—such, perhaps, as might mean an immense increase in output for both.

It is true that, unless operating conditions are understood, the use of such information is often more than useless. It is sometimes even dangerous. Costs as a measure of output are, however, the readiest measure of accomplishment that we have in industrial matters, and a free exchange of ideas along this line often opens up a mine of information as to desirable and undesirable methods, efficiency of workmen, efficiency of machines, and many other matters of highest importance—not the least of which are inherent faults with many systems of accounting. If there is anything about which secrecy should not be observed, that thing is the cost of manufacturing. Such secrecy is a stumbling block to those practicing it and to the whole engineering profession.

When that letter of refusal from the vice-president and general manager was being written the ink was scarcely dry on sworn statements giving the identical information requested of my acquaintance which this manager's road had sent to the Interstate Commerce Commission in answer to the order of the commission of October 31st, 1910.

The comparison of the costs of this manager's shops, with those of twenty-two other railroads, forms the theme of this article. Their publication seems worth while, because it is fair to assume that this ever-pervading secrecy has kept the different roads in ignorance of the widely divergent results made apparent in the tables. It also seems worth while because of some wonderful results in lowering costs known to the writer by exactly similar methods—all of which were accomplished through correspondence only by the intelligent work of an occupant of the much ridiculed "swivel chair."

The tables show conditions that are nothing short of astounding. They provide a plentiful supply of pacemakers. A glance at the table marked "Summary of costs of repairs per mile" will show that no road need be slighted. For since no one road excels in more than one operation, every one can select at least two others for its pattern.

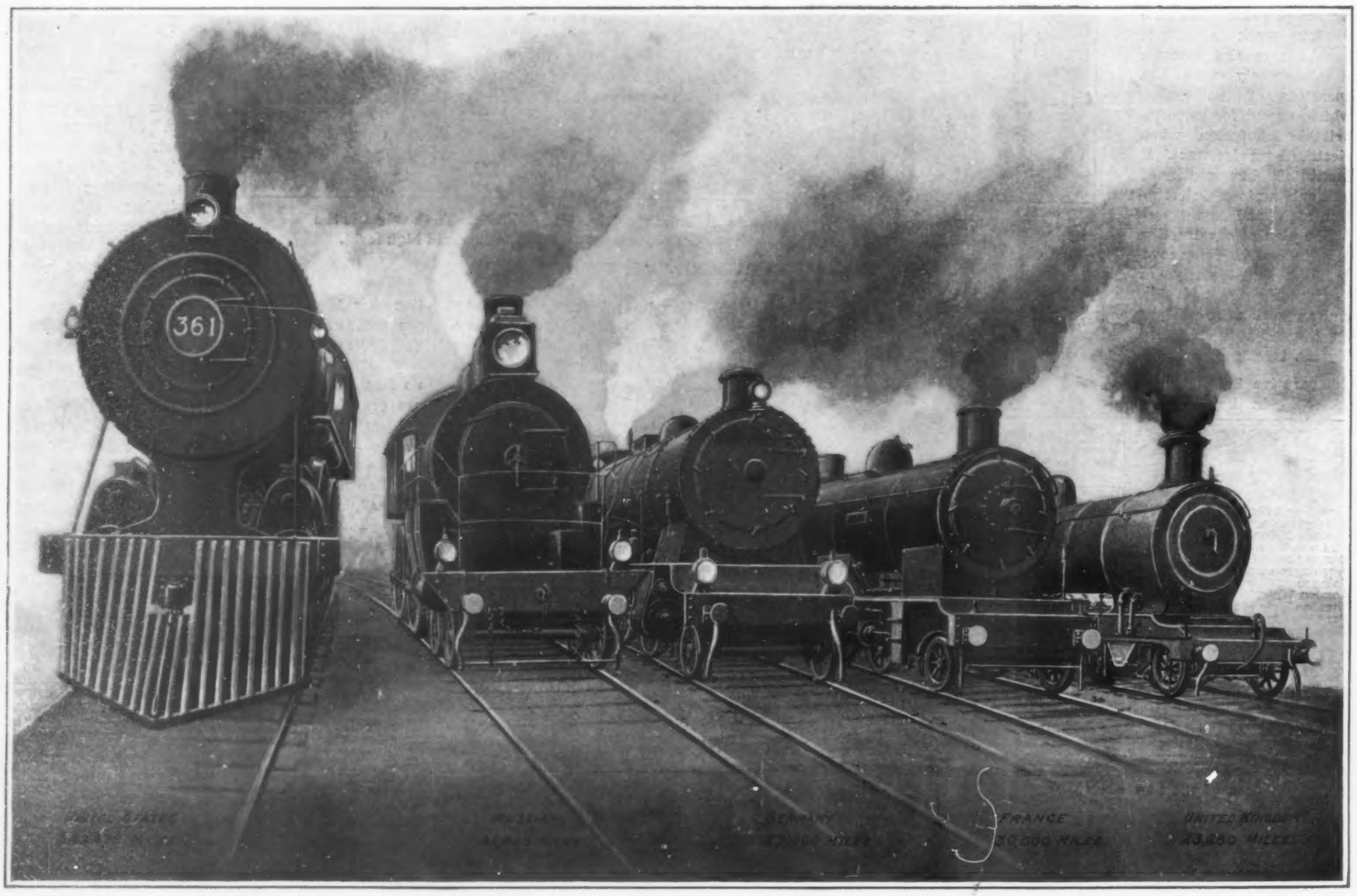
**The Railroad's Objections to the Efficiency "Doctors."**

Before discussing the table further, it is pertinent to remark on some of the objections raised by the railroads to the introduction of efficiency methods advocated by Mr. Brandies' witnesses. After the bald assertion the railroads cannot apply these methods, one of the principal objections is that specialists are essential and that the supply of such specialists is extremely limited. Another is the time required to put the methods in force. A very considerable part of this time is required in accurately ascertaining the output—in determining the measure for the pacemaker. The method of ascertaining the output is to place stop watches in the hands of trained experts. Of necessity, this method is slow at best.

Still another objection is that the orders of those specialists must be supreme. And this requires the interjection of outsiders between the management and their employees. Another is that the specialized knowledge of these experts is of such high order that it does not stick with the ordinary mechanic after the withdrawal of the expert.

These are only some of the more important objections. All of them do not seem to be well taken.

Luckily, however, there is a way to promote an immense amount of efficiency and meet all the objections which the railroads have raised. As has been shown




MAGNITUDE OF LEADING RAILROAD LINES OF THE WORLD REPRESENTED BY SIZE OF LOCOMOTIVES

above, they need not go outside of their own large family. Certainly it is not unreasonable to expect that one railroad can accomplish what has already been accomplished by another railroad. The tables have been computed and tabulated from figures submitted by the railroads themselves. Even cursory examination of them would seem to point a lesson to any prudent railroad manager.

**Possible Savings**

Without attempting to give advice to any of these managers as to how to run their business, it would seem from an examination of the table of locomotive repairs, for example, that the Erie could, with profit, send their locomotive repair men to investigate the shops of any of twenty-two other railroads. In the matter of freight car repairs on these same roads, among which the Erie is the eighteenth on the list, there are seventeen freight car repair shops from whom the Erie can get information of value. Likewise, in the matter of repairing passenger cars there are sixteen available fountains of information.

If after such an investigation the Erie attained the low cost per mile for her repairs already attained according to their own statements on the Minneapolis & St. Louis for locomotives, on the Toledo, St. Louis & Western on passenger cars, and on the Chicago & Alton for freight cars, her costs for these three items would be changed thus:

| | Present Cost to Erie. | Possible Cost to Erie. |
|---|---|---|
| Locomotive repairs.. ... ........ | $1,918,943 | $794,123 |
| Passenger car repairs. ........... | 296,812 | 87,332 |
| Freight car repairs.............. | 1,449,487 | 525,004 |
| Totals ...... ............... | $3,695.242 | $1,406,459 |

Here then is apparent a possible saving for this one road of over two million and a quarter for a period of six months, or over four and one-half million dollars ($4,500,000) for a year. A wonderful opportunity awaits the establishment of some central committee.

Glance at the percentage of difference between the various roads at the right-hand side of the table, running as they do up into several hundred per cent. Now compare these with the eight, ten or twenty per cent promised by some promoting company—and remember that such promises at once stamp such a company as a wild-cat, get-rich-quick scheme. After this mental exercise the significance of the differences in the railroads' percentages can be appreciated.

I am aware that it can be argued that the policy of one road for letting its rolling stock run down and another for keeping its in prime condition will account to a certain extent for the large differences. This argument might possibly apply to a single set of figures. It can scarcely apply when all are so different. And against such an argument can be cited the costs of individual items of repairs submitted at the same time by the different roads which showed even a greater difference than any recorded in the tables printed herewith. For example, turning locomotive axles ten inches diameter ran all the way from eighty cents for the lowest road to five dollars for the highest; bolting up front ends of locomotives ran from fifty cents to four dollars and eighty-one cents; applying wheels to locomotives ran from eighty cents to eight dollars and thirty-five cents, and so on. These examples cited are those showing the greatest differences. It is not within the scope of this article to print all the answers to all the detail operations, but it can be said that in practically all matters there ran a *very* wide divergence between the cost of the highest road and those of the lowest. And like the repairs that are tabulated for locomotives, the work was such as the roads are called upon to repeat day after day and year after year. It should be noted that the figures are based on miles of travel and not on length of road.

The figures given for the Erie show the possible savings for a single road by simply using methods already in vogue in the shops of other roads for work of exactly the same nature. The twenty-three big railroads given in the tables represented about one-quarter of the mileage made by all the roads in the country. The total for all roads, as given by Poor's Manual for last year, was one billion, one hundred and forty-one million for locomotives, about five hundred million miles for passenger cars and six hundred million miles for freight cars.

If the highest, lowest and average figures per mile of the twenty-three roads are applied to the mileage of all roads in the United States, there would be this startling difference in cost:

| | Possible Cost (All Roads), Using Highest Figures per Mile. | Possible Cost (All Roads), Using Lowest Figures. | Cost if Average of 23 Roads is Used. |
|---|---|---|---|
| Locomotive repairs.. | $202,000,000 | $82,000,000 | $132,000,000 |
| Passenger car repairs. | 48,000,000 | 9, 00,000 | 27,500,000 |
| Freight car repairs... | 218,000,000 | 51,0.0,000 | 136,200,000 |
| Totals.... ....... | $468,0[illegible]0,000 | $142,000,000 | $295,700,000 |

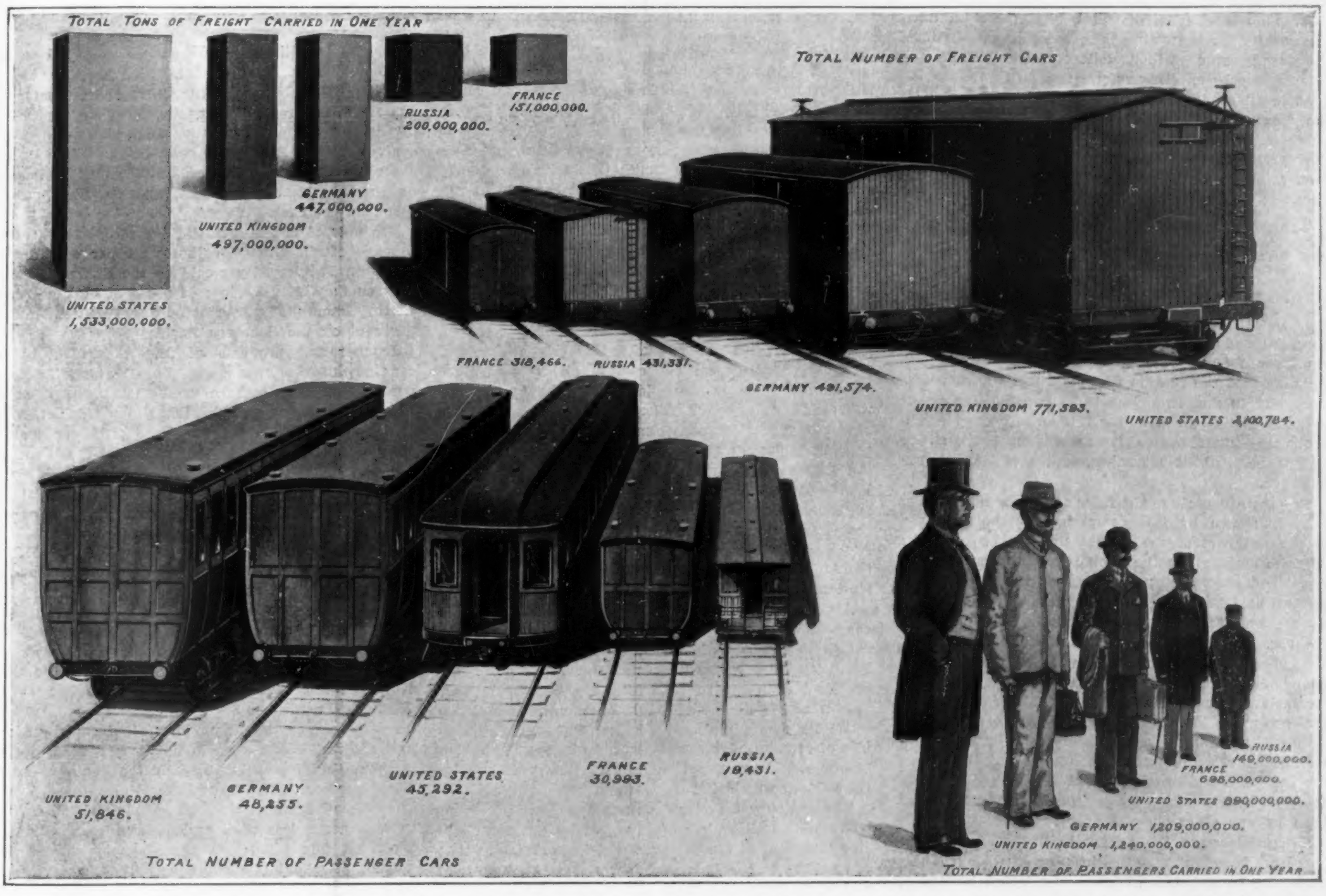
Locomotive Repairs—April to September, 1909.

| Name of Road. | Locomotive Miles. | Cost of Locomotive Repairs. | Cost per Mile. | Percentage of Increase Over Lowest. |
|---|---|---|---|---|
| | | | Cents | |
| Minneapolis & St. Louis. ...... | 1,161,982 | $83,301 | 7.2 | Low. |
| Chicago, Mil. & St. Paul........ | 15,198,179 | 1,180,659 | 7.8 | 8 |
| Toledo, St. Louis & Western... | 1,012,647 | 83,200 | 8.2 | 14 |
| Chicago & Northwestern..... .. | 17 947,553 | 1,480,056 | 8.2 | 14 |
| Chicago & Alton ... ..... ...... | 3,327,101 | 275,145 | 8.3 | 15 |
| Boston & Maine...... .......... | 10,688,592 | 907,005 | 8.5 | 18 |
| N. Y., N. H. & Hartford. ...... | 11,596,181 | 1,002,677 | 8.6 | 19 |
| Pere Marquette................ | 4,684,131 | 404,750 | 8 7 | 21 |
| N. Y. Central & Hud. River.... | 22,042,276 | 2,084,108 | 9.5 | 32 |
| Chicago, Bur. & Quincy........ | 16, 94,350 | 1,574,679 | 9.6 | 33 |
| Chicago, R. I. & Pacific..... .. | 15,395,897 | 1,500,342 | 9.8 | 36 |
| Del., Lack. & Western ... .. .. | 6,112,543 | 618,205 | 10.1 | 40 |
| Wabash... ...................... | 7,812,418 | 824,171 | 10.5 | 46 |
| Illinois Central................ | 14,359,641 | 1,760,134 | 12.2 | 70 |
| Baltimore & Ohio........... .. | 19,640,804 | 2,538,852 | 12 9 | 79 |
| Iowa Central.... ............ .. | 1,019,697 | 133,430 | 13.1 | 82 |
| Missouri Pacific.......... .... .. | 7,109,721 | 1,026,253 | 14.4 | 100 |
| Atch., Topeka & Santa Fe...... | 14,551,869 | 2,162,407 | 14.9 | 107 |
| Lehigh Valley.... ............ | 6,083,732 | 915,905 | 1 .0 | 115 |
| Pennsylvania. ......... .... | 26,188,635 | 4,074,065 | 15.5 | 115 |
| Philadelphia & Reading........ | 7,257,714 | 1,171,025 | 16.1 | 123 |
| Delaware & Hudson.......... .. | 4,307,858 | 693,173 | 16.1 | 123 |
| Erie... ............... .... | 11,029,486 | 1,948,043 | 17.7 | 146 |

The tables are taken from the figures for six months of 1909, and were those first made up. In order to see that there was no peculiar reason for the remarkable differences shown for that year, those for a similar period for 1910 were then tabulated. Space does

Summary of Costs of Repairs Per Mile—April to September, 1909.

| Name of Road. | Freight Car Repairs. | Locomotive Repairs. | Passenger Car Repairs. | Total Repairs. | Percentage of Increase Over Lowest. |
|---|---|---|---|---|---|
| | Cents. | Cents. | Cents | Cents | |
| Chicago & Alton ... ...... ... | 8.5 | 8.3 | 3.4 | 20.2 | Low. |
| Toledo, St. Louis & Western... | 14.0 | 8.2 | 1.8 | 24.0 | 19 |
| Chicago & Northwestern...... | 13.3 | 8.2 | 3.6 | 25.1 | 25 |
| Pere Marquette. ... ....... | 13.8 | 8.7 | 4.6 | 27.1 | 34 |
| N. Y., N. H. & Hartford...... | 14.6 | 8.6 | 5.6 | 28.8 | 43 |
| Boston & Maine .... .... | 15.5 | 8.5 | 5.2 | 29.2 | 45 |
| Minneapolis & St. Louis.. . .. | 16.8 | 7.2 | 5.3 | 29.3 | 45 |
| Chicago. Minn. & St. Paul...... | 17.8 | 7.8 | 4.3 | 29 9 | 48 |
| Chicago, R. I. & Pacific. .... | 17.8 | 9.8 | 4.0 | 31.6 | 57 |
| Wabash. .. . ......... . | 17.7 | 10 5 | 3.7 | 31.9 | 58 |
| Iowa Central ................ | 14.2 | 13.1 | 7.4 | 34.7 | 72 |
| Chicago, Bur. & Quincy........ | 22.5 | 9.6 | 4.2 | 36.3 | 80 |
| Missouri Pacific............... | 16.5 | 14.4 | 7.6 | 38.5 | 91 |
| Delaware & Hudson.. ......... | 17.6 | 16 1 | 5.1 | 38.8 | 93 |
| Baltimore & Ohio. ......... | 22.7 | 12.9 | 4.0 | 39.6 | 97 |
| Del., Lack. & Western. .... | 22.0 | 10.1 | 8.8 | 40.9 | 103 |
| Atch., Topeka & Santa Fe..... | 18.5 | 14.9 | 9.6 | 43.0 | 114 |
| N. Y. Central & Hudson River. | 29 4 | 9.5 | 5.5 | 44.4 | 121 |
| Erie ... ......... ......... | 23.3 | 17.7 | 6.1 | 47.1 | 134 |
| Lehigh Valley... ........... . | 28.3 | 15.0 | 5.3 | 48.6 | 141 |
| Pennsylvania ............... | 30.4 | 15.5 | 5.1 | 51.0 | 155 |
| Illinois Central.......... ....... | 34.7 | 12.2 | 7.0 | 53.9 | 168 |
| Philadelphia & Reading........ | 36.4 | 16.1 | 9.6 | 61.9 | 207 |




GRAPHICAL COMPARISON OF THE ROLLING STOCK AND FREIGHT AND PASSENGER TRAFFIC OF THE WORLD'S LEADING RAILROADS.

not permit the publication of these tables for 1910. It can be stated, however, that although the figures were changed slightly because most of the roads raised wages during the intervening period, the same general variation obtained; the highest and lowest figures for that year (1910) being 17½ and 8.1 cents per mile for locomotive repairs, 8.7 and 2.5 cents per mile for passenger car repairs, and 34.1 and 10.3 for freight car repairs.

It would have been interesting to have had the rates paid workmen published along with these remarkable differences. Some light would probably have been thrown on the relation between high or low costs of work and high or low monthly wage rates of the workmen. I say monthly wage rates, for when work is paid for by the piece the unfortunate and widely prevalent custom of cutting piece rates often results in all sorts of deception on the part of the workmen. And a high hourly rate one day will be followed by the workman decreasing his output the next. He feels, and with justification, that the rates will be cut if he is able to make an unusually high amount in a month. Diminished output of the workmen, with attendant expensive delays, are the results, all of which are paid for dearly by the stockholders.

It would seem from the tables that there is ample opportunity for the railroads to recover several times the twenty-seven million dollars expected from the rate income by effecting reform from within.

After all roads have attained the lowest figures of the "low" road by using that road's methods, the habit of saving will probably have become so fixed that perhaps the "efficiency doctors," as they have been called, will be sent for.

## Transcontinental Railroads in the United States

*(Continued from page 589.)*

Union Pacific and the Atchison, Topeka & Santa Fé. Some idea of what this competition and the potential and often active competition by water has done for freight rates may be gained by understanding that the rate on first class freight from New York city to San Francisco is $3 per 100 pounds, or $67.20 per long ton, while the rate on fifth class (highest class) merchandise from London, England, to Birmingham, about 125 miles, is 49s 4d ($9.84) per long ton.

Transcontinental freight rates are really much lower than is shown by this comparison, because only a very small part of the freight that moves from the Atlantic seaboard to the Pacific coast moves on what are called class rates; and even at these rates only a small part takes the first class rate, there being six classes, and each succeeding class is proportionately cheaper. The great bulk of the freight moves on what are called commodity rates; that is, so much per 100 pounds is charged for a certain commodity—oranges, for instance, or lumber; and commodity rates in general are much lower than class rates.

Competition and the genius of American railroad men have worked along the line of reducing the charge for the freight business, and the results are probably more strikingly shown by the transcontinental roads than by any other class of roads.

Competition and the genius to meet this competition have been just as active in the passenger business as in the freight, but with the result that instead of reducing the cost per passenger per mile as the cost per ton per mile for freight was reduced, the railroads have found that what the public wanted was not so much cheaper passenger rates as a very high class of service. Of course, in the case of each one of the transcontinental roads the freight business is a far more important source of revenue than the passenger business, but the passenger business is absolutely essential to the roads; and to the great majority of the public, passenger service is the criterion by which the efficiency of any given railroad is judged.

The varying seasons have a considerable influence on the movement of freight over the northern or southern lines. For instance, oranges first begin to move east from California in considerable quantities in the early part of January. At this time the southernmost route, the Southern Pacific, can bid successfully for the business. A little later the Atchison, Topeka & Santa Fé puts in its bid also for this business, and by the time spring has come the Southern Pacific-Union Pacific route through San Francisco and Ogden to the East is hauling solid trains of oranges.

In the summer the northern lines—the Northern Pacific, the Great Northern and the St. Paul—get their share of the fruit business, canned fruits, dried fruits, apples, etc., moving from California to the East.

The seasons make a big difference also as to which

| | Chicago, Milwaukee and St. Paul.[8] | Northern Pacific. | Great Northern. | Union Pacific. | Atchison, Topeka and Santa Fe. | Southern Pacific. |
|---|---|---|---|---|---|---|
| Length of main line from East to Pacific,[1] (miles) | 1,771[2] | 1,907[3] | 1,855[4] | 1,783[5] | 2,576[6] | 2,487[7] |
| Total road mileage | 8,714 | 5,814 | 7,020 | 6,401 | 9,961 | 10,077 |
| Total capitalization | $25,000,000<br>424,813,231 | $546,566,000 | $429,610,909 | $613,594,360 | $581,697,183 | $399,483,171 |
| Number of locomotives | 1,567 | 1,430 | 1,127 | 1,134 | 1,923 | 1,821 |
| Number of passenger cars | 1,217 | 1,119 | 885 | 825 | 1,375 | 1,958 |
| Number of freight cars | 5,644 | 44,506 | 44,832 | 26,043 | 57,781 | 45,185 |
| Total tons of freight | 32,236,798 | 18,268,998 | 23,224,972 | 15,312,211 | 19,448,590 | 25,962,704 |
| Total ton miles | 6,242,879,692 | 5,419,084,365 | 5,678,787,816 | 5,997,233,894 | 7,012,896,589 | 6,628,685,724 |
| Average length of haul (miles) | 596<br>174 | 297 | 245 | 346 | 361 | 243[11] |
| Average train load of revenue freight[9] (tons) | 387<br>276 | 429 | 518 | 452 | 389[10] | 396 |
| Total number of passengers carried | 18,182,361 | 9,639,994 | 8,343,557 | 8,306,930 | 13,675,343 | 21,196,324[12]<br>40,190,200[13] |
| Average receipts per passenger per mile (cents) | 2.50<br>1.88 | 2.18 | 2.20 | 2.122 | 2.06 | 2.19 |

[1] The length of main line is from eastern terminus to western terminus of the route. [2] The Chicago, Milwaukee & St. Paul main line runs from St. Paul to Tacoma. This includes the Chicago, Milwaukee & Puget Sound, which is the operating company for the Pacilc Coast extension of the St. Paul. [3] The Northern Pacific main line runs from St. Paul to Tacoma. [4] The Great Northern main line runs from St. Paul to Tacoma. [5] The Union Pacific main line really only runs from Council Bluffs to Ogden. The mileage given in our table is the main line mileage from Council Bluffs to San Francisco. [6] The Atchison, Topeka & Santa Fe main line runs from Chicago to San Francisco. [7] The Southern Pacific main line runs from New Orleans to San Francisco. [8] All of the figures in this column are the total figures of the St. Paul itself and the Puget Sound, with the exception of the figures for capitalization, and the averages for length of haul, train load and receipts per passenger per mile. The $424,813,231 capital is the outstanding capital of the Chicago, Milwaukee & St. Paul, and the $25,000,000 represents the outstanding bonds of the Puget Sound not held in the treasury of the parent company. In the averages, the first figure is for the Puget Sound and the second figure for the St. Paul. [9] Does not include company freight. [10] Includes company freight. This makes the average train load of the Atchison appear considerably larger in comparison with the other roads than it really is. For instance, the Southern Pacific train load as shown in our table is 396 tons. If company material were included in that figure, it would be 476 tons. [11] The tonnage of company material is included in arriving at this average; but it is rather hard to say whether the average is much affected or not. [12] Omitting ferry and suburban. [13] Including ferry and suburban.

route gets the bulk of the passenger service. In the summer the St. Paul and its northern neighbors—the Northern Pacific and Great Northern—can flood the New York city ticket offices with highly colored literature describing the cool breezes, the cool nights and the magnificent scenery on their lines. In December and January the Southern Pacific's southern route, which in point of time cannot compete at all with the other lines, gets nevertheless a large passenger business because it can offer the prospective traveler a journey through the semi-tropics almost all the way from New York. The Southern Pacific's southern route for passengers is to take them by boat from New York down into the Gulf of Mexico and transfer them at New Orleans to trains.

Few people realize how keen this competition for passenger traffic from the eastern cities to California has become, and few indeed realize how much the railroads have done, or in how many little ways they have extended their activities in order to make their road the more attractive. The fact, for instance, that the Yellowstone Park is on the line of the Northern Pacific is as truly an asset of the Northern Pacific's as is its passenger station at Seattle; the fact that the Grand Canyon of Colorado is on the line of the Atchison, Topeka & Santa Fé is as truly an asset of the Atchison's as is its interest in the union passenger station at Los Angeles.

A very interesting development for instance in this competition for the California passenger business is shown in the case of the Atchison and the Southern Pacific in the development of meal service. The Southern Pacific, taking its hint from the deservedly well known and well advertised Fred Harvey meals, has made its own dining car service, apparently regardless of cost, an achievement truly to be proud of. The money loss from operation is more than made up by the gain in popularity.

The ordinary traveler does not make the trip from Chicago to California so often that he can form any fair judgment of the percentage of through trains that are on time. His judgment is based on a single trip, and if, therefore, his train is two hours late, he feels, at least, that the A. & B. road that he has traveled on usually has its trains two hours late. Since there is no double-track transcontinental road at present, although the Union and Southern Pacific are planning to have their connecting lines between Ogden and San Francisco double-tracked, this fast passenger traffic has to be handled over a single-track line, already pretty fully taxed to take care of the local passenger and local and through freight business. Nevertheless, the road's reputation, and therefore the passenger department's ability to get increased business, depends on getting the fast train through on time, and the efforts on the part of the operating man that are used in doing this are sometimes almost beyond belief.

One of the first things that a traffic man wants to know about a road is what commodities it carries. An expert can get a pretty good idea of this from studying a map of the road. Most roads report the tonnage of each general class of commodities to their stockholders in their annual reports, and all roads are required to report this to the Interstate Commerce Commission.

Of the total tonnage carried on the Great Northern, 19 per cent is products of agriculture, such as grain and so on. Of the total tonnage of the Northern Pacific, 19 per cent is products of agriculture; on the Chicago, Milwaukee & St. Paul, 19 per cent is products of agriculture; on the Union Pacific, 24 per cent is products of agriculture; on the Denver & Rio Grande, 4 per cent; on the Atchison, 23 per cent, and on the Southern Pacific, 20 per cent.

On the Great Northern, live stock and animal products, such as dressed meat, etc., form but 1 per cent of the total tonnage; on the Northern Pacific, 2 per cent; on the St. Paul, 5 per cent; on the Union Pacific, 6 per cent; on the Denver & Rio Grande, 1 per cent; on the Atchison, 8 per cent, and on the Southern Pacific, 4 per cent.

Products of mines furnish 58 per cent of the total tonnage of the Great Northern; 24 per cent on the Northern Pacific; 32 per cent on the St. Paul; 34 per cent on the Union Pacific; 84 per cent on the Denver & Rio Grande; 28 per cent on the Atchison, and 28 per cent on the Southern Pacific.

Lumber and products of forests furnish 12 per cent of the total tonnage on the Great Northern; 38 per cent on the Northern Pacific; 13 per cent on the St. Paul; 14 per cent on the Union Pacific; 2 per cent on the Denver & Rio Grande; 12 per cent on the Atchison, and 21 per cent on the Southern Pacific.

Manufactures furnish 6 per cent of the total tonnage on the Great Northern; 10 per cent on the Northern Pacific; 18 per cent on the St. Paul; 13 per cent on the Union Pacific; 6 per cent on the Denver & Rio Grande; 17 per cent on the Atchison, and 17 per cent on the Southern Pacific.

This is all carload business, that is, each shipment consists of at least one carload. The less than carload freight business is generally called merchandise, and of the total tonnage of freight carried by the Great Northern but 3 per cent was merchandise; by the Northern Pacific but 5 per cent; by the St. Paul but 10 per cent; by the Union Pacific but 5 per cent; by the Denver & Rio Grande but 1 per cent; by the Atchison but 7 per cent, and by the Southern Pacific but 8 per cent. The rest of the total tonnage, besides the carload business that we have classified, and the miscellaneous less than carload business, called merchandise, is made up of miscellaneous carload shipments. It should be noted here that the very high percentage of products of mines, carried by the Denver & Rio Grande, is caused by the great quantities of ore which the Denver & Rio Grande hauls out of the mountains in Colorado, and this business is not transcontinental business in any sense of the word. Of course, in giving the above averages, it was impossible to include the Western Pacific's or Missouri Pacific's business with that of the Denver & Rio Grande, and we have not included the St. Paul's Pacific Coast extension with the figures for the St. Paul itself. The only way to get any comparison between roads of different lengths as to what they are earning, is to reduce earnings to a per mile basis. As a matter of fact, a per mile basis does not make even a fairly accurate comparison. Difference in conditions, difference in commodities carried and differences in physical location must be taken into consideration to make any sort of comparison, so that there is shown herewith total earnings in the year ended June 30th, 1910, of each of the roads discussed:

| | Freight Revenue. | Passenger Revenue. | Total, Including Mail, Express, etc. |
|---|---|---|---|
| Great Northern | $46,675,734 | $17,025,682 | $64,465,370 |
| Northern Pacific | 48,758,736 | 24,250,818 | 74,525,826 |
| C., M. & St. P. | 44,909,137 | 18,689,198 | 64,846,894 |
| Union Pacific | 61,479,680 | 25,324,254 | 88,506,465 |
| D. & R. G. | 17,306,613 | 6,020,407 | 23,563,437 |
| A., T. & S. Fe | 71,194,056 | 32,013,919 | 104,993,195 |
| Southern Pacific | 77,018,554 | 45,221,129 | 124,523,905 |

# Hygroscopes—Quaint and Curious

By C. Fitzhugh Talman

PROPERLY speaking, the duty of a hygroscope is a modest one—viz., to show whether the air is dry or moist—while to the hygrometer is assigned the more difficult task of measuring atmospheric moisture. Owing, however, to the fact that the approach of a barometric depression, with its attendant rain or snow, is accompanied by an increase in the humidity of the air, the hygroscope serves as a rough kind of weather glass, and, in some of its forms, is often referred to as a "barometer."

The great majority of hygroscopes are mere toys; but since they are in common use the world over, and are often very ingeniously devised, science cannot afford to ignore them, but should rather endeavor to enlighten the public as to their true character.

A great number of substances possess in a marked degree the property of absorbing moisture when the air is humid, and giving it out again when the air becomes dry. Such substances are said to be hygroscopic. Their property of changing their condition in response to changes in the humidity of the atmosphere is taken advantage of in the construction, not only of hygroscopes, but also of many forms of hygrometer.

The twisted fibers of hemp, catgut, etc., readily absorb moisture, swell, and cause a longitudinal shrinking of the ropes and cords made of such materials. This fact is illustrated in the familiar anecdote of the erection of the Egyptian obelisk that stands in the middle of the square facing St. Peter's at Rome. The following is one of several versions of the story:

"The obelisk consists of a single piece of red granite, more than 85 feet high, and 9 feet square at the base. It had been thrown down during the decline of the Roman Empire, and had remained under heaps of rubbish during many centuries. After several futile attempts, the huge block was suspended in the air, and as the ropes which held it had somewhat stretched, they could not make the base of the obelisk reach the summit of the pedestal, when a man in the crowd called out, 'Wet the ropes.' This was done, and the column, as of itself, gradually rose to the required height, and was placed on its pedestal."

If a weight be suspended from a cord, moisture will not only tend to lift the weight, but will also give to the cord a twisting motion.

These two processes—shrinking and twisting—explain the operation of some of the most interesting forms of hygroscope. An illustration of the former is seen in the *Capuchin* (Fig. 6). A bit of catgut within the figure is attached immovably at one end, the other end being fastened to the monk's cowl, which is hinged at the back. When, in consequence of the increasing moisture of the atmosphere, the catgut shrinks, the cowl is drawn over the monk's head, who is thus supposed to prepare himself for wet and stormy weather. When the air grows dry again, the catgut lengthens and the cowl falls back.

The twisting process is illustrated in what is generally called the *Dutch weather house* (Fig. 7). The weather house was invented about 1700. It was a more familiar object in American homes fifty years ago than it is to-day. It consists of a catgut cord, from which is suspended a little horizontal platform of wood, bearing the figure of a man at one side and that of a woman at the other. Sometimes the man carries an umbrella, and the woman a fan or a parasol. In an average condition of atmospheric humidity both figures stand inside the house. If the air grows moister the man emerges from the door, if dryer the woman; these movements being due, of course, to a slight change in the twist of the cord. By the Germans these figures are called, respectively, *Wettermännchen* and *Wetterweibchen*.

The same process is illustrated in the famous *Wetterjungfrau* (Fig. 5), a chandelier bearing a female figure hanging in the Rathhaus of Rothenburg, Bavaria. The chandelier hangs from a hempen rope. In moist weather the figure faces the window, in dry weather it turns in the opposite direction.

Many plants possess hygroscopic properties. The common pimpernel (*Anagallis arvensis, L.*) owes its sobriquet "poor man's weather glass," or "shepherd's weather glass," to the fact that it is reputed to close its little scarlet blossoms before rain. It is the experience of the present writer that this prophetic faculty of the pimpernel cannot be depended upon, at least in America, for he has often found the blossoms wide open both before and during a shower. There are, however, several other plants that exhibit hygroscopic movements whenever suitable conditions exist. The beard of the oat is decidedly hygroscopic, and has often been used in the construction of hygrometers and hygroscopes. Lana, in 1670, fastened a bit of convolvulus stem vertically at the bottom of a little tube or vase, around the rim of which was placed a divided circle. A light figure of a man was attached to the stem, and as the latter twisted a spear in the man's hands pointed to successive graduations of the scale, indicating various degrees of humidity.

Two curious forms of apparatus, the *butterfly hygroscope* and the *foil hygroscope*, were described a few years ago by Mr. Richard Inwards, the well-known English authority on weather folk-lore.

The former of these utilizes the hygroscopic properties of the awn of the Egyptian wild oat (Fig. 4), the lower part of which twists about with variations in the humidity of the atmosphere. Fig. 3 shows one wing of the butterfly—made of paper, painted in water colors. The lower end of an awn is fastened down by the screw shown at the left, the upper is attached to the wing. The other wing is attached to another awn, which, however, must be turned in the opposite direction. It is best to set the wings on a very damp day, when after loosening the screws, the wings may be pressed together in a vertical position, and the screws lightly turned so as to hold them there. With a little experimenting, it is easy to adjust this philosophic toy in such a manner that the wings will expand in dry weather and close in wet.

The foil hygroscope (Fig. 2), which is said to be one of the most sensitive devices of its class, is best described in Mr. Inwards's own words:

"It consists of three slips of the foil used by jewelers to enhance the effect of

(Continued on page 610.)


**Fig. 1.—The "Chameleon Barometer," a chemical hygroscope.**

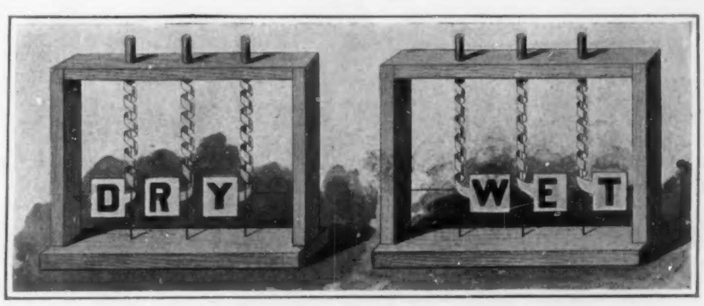



**Fig. 2.—The silver-foil hygroscope.**

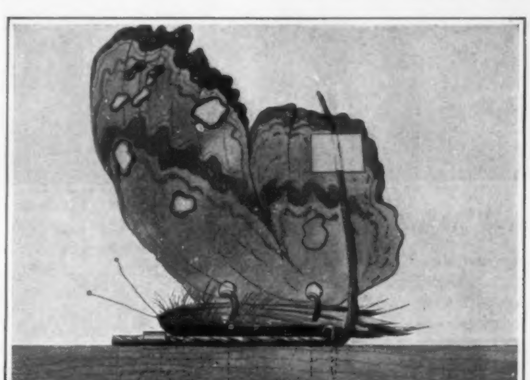


**Fig. 3.—The butterfly hygroscope.**

**Fig. 4.—Egyptian oat used in making the butterfly hygroscope.**

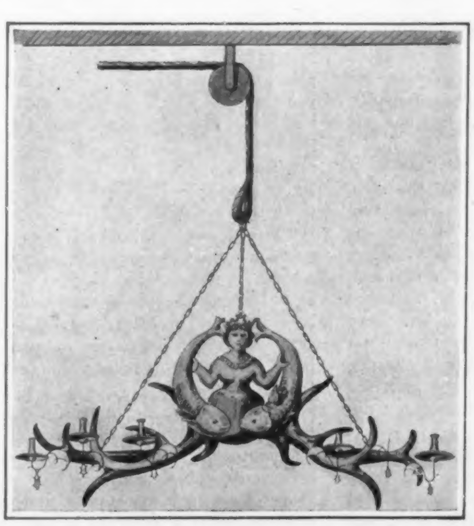


**Fig. 5.—Hygroscopic chandelier in the Rathhaus at Rothenburg.**

**Fig. 6.—The "Weather Capuchin."**

**Fig. 7.—The Dutch weather-house.**

# Abstracts from Current Periodicals

## Phases of Science as Other Editors See Them

### False Appearances Produced by the Stereoscopic Combination of Comet Photographs

IN the monthly notices of the Royal Astronomical Society Prof. E. E. Barnard discusses certain false appearances which may be produced in the preparation of celestial stereo-photographs owing to the differential motion, for instance, of the different parts of a comet. Prof. Barnard writes:

"The stereoscope enables one to see objects in perspective by the combination of two photographs taken from a slightly different point of view. One way to accomplish this effect is to shift the position and direction of the camera by a proper amount between the taking of the two pictures. Essentially the same effect would be produced by the bodily displacement of the object with the camera stationary, provided all of the background were itself too distant for parallactic displacement. Both these methods would require that there were no relative change in the individual parts of the object in the interval between the two pictures. For celestial bodies, where our base line is too small to give any appreciable parallax, the last of the two methods is resorted to. In the case of the Moon the perspective is obtained by the aid of libration; and as the phase has to be exactly the same, a very long interval is required. In the case of a bright asteroid an interval of an hour, or of a proper motion star of several years, will produce the required effect. The short interval is also applicable to a comet, and beautiful and startling effects are produced by this means in the case of a comet with a tail. Few bright comets, however, are above the horizon long enough to permit the two photographs to be made for this purpose. On account of its high north declination, and its consequent visibility through all or nearly all the night, comet c 1908 (Morehouse) was specially suited for stereoscopic photographs, and the material acquired for this purpose is abundant. The combinations of proper sets of these pictures show the comet in beautiful relief suspended alone in space, as we know it is in reality, with the various parts of the tail in individual perspective. There is a wonderful effect of reality in these pictures, and the filmy, breath-like character of the comet is shown as no single picture can ever hope to show it. These photographs are marvelously instructive, and one is tempted to deduce certain 'facts' from the appearance which are probably entirely erroneous.

"This is such a serious matter, and one so fascinatingly delusive, that I have thought it worth while to draw attention to the chances for serious errors that are inherent in the very success of the experiment in the case of a comet.

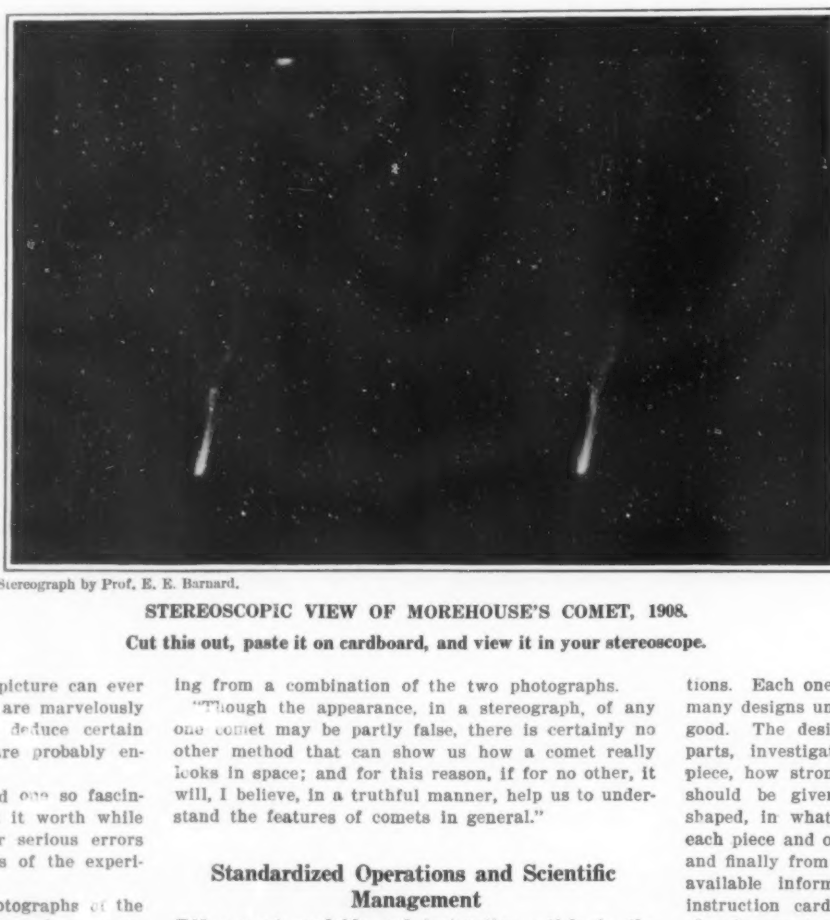
"I have combined a number of photographs of the present comet, in which the motion in an hour or so, between the exposures, permits stereoscopic effect. One of the most remarkable of these combinations is one of 1908, October 15th. On this date there was a sudden twist or break in the tail, which formed irregular cloud-like masses that moved out from the comet along the general direction of the tail. In the stereoscope these two pictures produce an exquisite object suspended in front of the stars. Apparently it is easy to see which are the farther and which the nearer parts of the comet. The south end of the long irregular mass at an angle to the tail is the nearer. From this the tail has a twisted or corkscrew form, the nearer and farther convolutions of which are at once evident. The straight stem-like tail emanating from the head passes behind this mass. On each side of the head is a small stream shot out at a considerable angle to the main tail. The south one of these apparently recedes from us at a large angle to the plane of the photograph.

"But how much of this perspective is real? I believe that there is but little of it that can be true. In the first place, these masses were receding from the comet and changing their actual forms, and especially their position angles, so that a pseudo-stereoscopic effect would be produced, and what is really the nearer portion of the comet may appear to be a distant part. Some of the features where the details were not changing rapidly—as, for instance, the short tail from the south side of the head—would probably not be affected much by the outgoing particles, and a true stereoscopic effect would be produced. I have my doubts about much of the rest.

"In connection with this subject I would say that I never need the stereoscope to combine these pictures. By a certain control of my eyes, any stereoscope picture is far more beautiful without the stereoscope, and I never use the instrument. The magnification of the image is somewhat less. When one has this command over his eyes he will never again use a stereoscope.

"While I believe that a good deal of the perspective on these stereograms is untrue, and that it does not accurately represent the actual appearance of the comet at the time, it must not be understood that I would discourage the stereographic study of comets. I believe that much can be learned of the general structure of these bodies from such a study. We must simply be guarded as to the relative perspective of the various parts of the comet at that time, as resulting from a combination of the two photographs.

"Though the appearance, in a stereograph, of any one comet may be partly false, there is certainly no other method that can show us how a comet really looks in space; and for this reason, if for no other, it will, I believe, in a truthful manner, help us to understand the features of comets in general."



Stereograph by Prof. E. E. Barnard.

**STEREOSCOPIC VIEW OF MOREHOUSE'S COMET, 1908.**

**Cut this out, paste it on cardboard, and view it in your stereoscope.**

### Standardized Operations and Scientific Management

IN a most readable and instructive article in the *Engineering Magazine*, Mr. Harrington Emerson shows what standardization means in efficiency engineering.

"Moses came down into camp with his tables of stone and the ten commandments," says Mr. Emerson. "It took one minute and fifty seconds to read them slowly and impressively. Moses expected that the tribes assembled would listen, practise, and become perfect before they reached the Promised Land. Thirty-five hundred years have elapsed and the breach of most of the commandments is still very popular. It is because the virtues extolled are not obvious, or instinctive, that they have to be graven on stone, that they have to be repeated weekly if not daily, that they have to be incorporated in our codes and enforced by our courts.

"The rope is made of many minor strands; these are twisted from the numerous threads, and these in turn have been spun from broken and carded fibers. The sheep's fleece is a unit, a matted mass that adheres and forms a whole, not because it is woven like a blanket, but because of its interwoven confusion and tangle. There is no popular English word for a single thread of wool. Pull one lock and the whole fleece comes, not because of orderly connection, but because of disorderly tangle.

"The march of a regiment is one thing, the surge of the crowd that jostles and sways us and upsets all orderly progress is another thing. The sheep is a silly creature, the only animal that would perish without the care of man, so no wonder its fleece is such a mess. The matted, tangled hair of some savages, hair plastered with mud, is comparable to the fleece, but civilized man settles the problem by clipping his head hair so that it could not tangle if it tried, settles his face hair by shaving off every vestige of it three to six times a week; but woman, more patient, with more capacity for taking pains, brushes and combs out her long locks, beginning at the ends, straightening a few inches at a time, then reaching higher up, rearranging all the parts already perfected, and so back to the head, until each of the 40,000 separate hairs lies in its own appointed place as to all the others, and all contribute to the marvelous and intricate creations that as a whole crown her lovely head. If it were not for the ideal plan the task would be hopeless. At least once a day does woman adjust her hair, the 40,000 single hairs to the general plan, and once a day should the 40,000 operations of the shop be straightened out in accordance with a general plan.

"The separate operations in a shop must flow into the final output; but from the expected output backward, there must be a plan that reaches back to each detail of every operation.

"It is one thing to build a battleship, taking up details as they occur—the haphazard method; it is another thing to make the plan first, place all the details where they belong in time, space, relation and perfection, and have them drop into place with the accuracy of a watch movement—the difference, in fact, between the running of sand through an unstandardized aperture, and the precision of the chronometer. Good results are not achieved by chance.

"One volume of the standard-practice instructions covering the manufacturing of the gasoline automobile truck car contains 278 isometric designs or illustrations, 314 pages of printed matter, and spaces for the times and rates of 1,231 distinct operations. Each one of these operations was preceded by many designs until one was accepted as approximately good. The design was split up into its component parts, investigation made as to material of each piece, how strong it should be, what heat treatment should be given, on what machines it should be shaped, in what sequence, by which worker! As to each piece and operation many time studies are made, and finally from the mass of accurately ascertained or available information, a carefully prestudied work-instruction card is made out. All these items of planning must precede the time and cost ratings. Are you appalled at the mass of detail that precedes the making of a book? If we have but 100 copies to print it is cheaper, quicker, and better than manuscript duplication; if we have three copies to make it is better to choose the typewriter and provide carbon manifolds than to write it out by hand. If we want only 300 screws and it takes three hours to set up the automatic machine and only three minutes to run out the screws, it is better to use the automatic. A modern activity, whether the operation of an industrial shop or a railroad, or of the turrets and guns of a battleship, is part of a gigantic, automatic machine; and it pays to plan in advance, not to trust to the haphazard.

"Nevertheless, the difficulties are very real and there is a middle ground between the optimism that underrates them and the despair that refuses to master them. There are between 8,000 and 16,000 separate pieces in a locomotive, and each railroad in the country wants a different design. One great railroad used 256 different styles of locomotives, so that there is an appalling lack of standards; but the more reason for beginning at once."

## The Theory of Svante Arrhenius in Regard to the Glacial Periods

SVANTE ARRHENIUS has advanced an ingenious theory to account for the glacial periods which have marked several stages of geological history. The earth radiates into space not only the heat which it receives from the sun, but also the heat which is conducted from its very hot interior. According to the experiments of Langley, the carbon dioxide and the water vapor, which the atmosphere contains, are more opaque to the heat rays of great wave length which are emitted by the earth, than to the waves of various lengths which emanate from the sun. Arrhenius infers that any increase in the proportion of carbon dioxide and water vapor in the atmosphere will increase the protection of the earth against cooling and will consequently raise the temperature of its surface. The theory assumes that the earth's atmosphere was poor in carbon dioxide and water vapor during the glacial periods, and rich in these gases during hot periods. It is interesting to see whether this ingenious and seductive theory, deduced from Langley's experiments, agrees with the results of various experiments made for the purpose of testing the theory, or with the general results of geological study.

This comparison is made by Robert Douville in a recent issue of *La Nature*, from which we abstract the following:

The carbon dioxide contained in the atmosphere comes in large part from volcanic eruptions. Hence, if the theory is true, the hot periods in which carbon dioxide is supposed to have abounded should also be marked by great volcanic activity. On this point geologists are not in agreement, and a lively discussion has been carried on in Germany, where Frech is the principal champion of the theory of Arrhenius, which is attacked by Emm, Kayser, Philippi, and other geologists. It is very interesting to see whether things have really occurred as if the theory of Arrhenius were true. If this is the case, the purely physical verification of the fundamental hypothesis of Arrhenius will lose a little in interest. It is conceivable that the theory might be verified more completely in nature than in the laboratory.

The experiments which relate to the physical hypothesis of Arrhenius are too numerous to be reviewed here. Arrhenius himself maintains that a diminution of the quantity of carbon dioxide in the atmosphere by one-half would lower the temperature of the earth's surface by 9 deg. F., half of this reduction of temperature being caused directly by the diminution in the quantity of carbon dioxide, and half by the associated reduction in the quantity of water vapor. Arrhenius studied the radiation from a body at the temperature of the laboratory to another body cooled to 112 deg. F., and which played, with respect to the first body, the part which interstellar space plays with respect to the earth. He found that the absorption of the thermal radiation increased continually with the mass of carbon dioxide employed. The proportion of heat absorbed sometimes exceeded 30 per cent, and the interpretation which Arrhenius had first given of Langley's experiments was completely confirmed by his later experiments. The German physicist, Koch, however, finds that the same mass of carbon dioxide absorbs more heat at high than at low pressure, a result which would appear, *a priori*, very unfavorable to the theory. But the experiments of Rubens and Ladenburg are the most important. They have been differently interpreted. Here are the facts. By studying with the spectroscope, the absorption bands produced by the interposition of a stratum of carbon dioxide of measured thickness before a body which emits long waves of "dark heat," it is found that there are three such bands, corresponding to wave-lengths of 2.6, 4.4 and 14.7 thousandths of a millimeter. The two bands first mentioned remain unchanged when the thickness of the absorbing stratum of carbon dioxide is increased, but the third band increases in width and thus gives evidence of increased absorption. The following table indicates the magnitude of this phenomenon, which accords with the theory of Arrhenius:

| | | | | | | |
|---|---|---|---|---|---|---|
| Absorption (per cent.). ................ | 9.2 | 14.8 | 18.3 | 20.2 | 21.5 | 22.4 |
| Thickness of absorbent stratum (cm.). | 4 | 20 | 100 | 200 | 300 | 400 |

Rubens and Ladenburg, who are not in favor of the theory of Arrhenius, estimate that this increase in absorption is too small to explain the glacial periods. This is not a necessary conclusion; but, at all events, the result of these experiments is contradicted by the result obtained by Kayser, who attempted to prove experimentally that at pressures higher than 3 inches of mercury, the amount of absorption is not influenced by increasing or diminishing the quantity of carbon dioxide. This physicist evidently paid no attention to the third absorption band.

Geology furnishes little evidence on either side. The theory of Arrhenius receives some support from the fact that the glacial periods of the Upper Carboniferous, the Permian, and the Tertiary follow periods (Carboniferous, Upper Cretaceous) in which enormous quantities of carbon were fixed in the forms of coal and lignite, and the quantity of carbon dioxide in the atmosphere was thus possibly diminished. The volcanic eruptions of the Upper Permian terminated the glacial period which occurred between the Carboniferous and the Permian. This is the only geological evidence in favor of the theory of Arrhenius. The unfavorable evidence is more abundant. The Permian and Tertiary were periods of great volcanic activity, and, on the whole, hot periods, which accords with the theory, but there is no parallelism in detail between temperature and volcanic activity. The rich flora by which we now know that the Tertiary period was characterized, proves that the climate cooled progressively from the Oligocene to the Miocene, and from the Miocene to the Pliocene. Now, the Miocene was a period of very great volcanic activity, which should have prevented this cooling if the theory of Arrhenius is correct, or if the temperature had not been influenced by some factor more powerful than the quantity of carbon dioxide in the atmosphere. Similarly, an almost uniform and very high temperature prevailed over the entire earth at the Mesozoic epoch, as is proven by the sub-tropical fauna found in Lower Cretaceous deposits on the west coast of Greenland. This fact does not accord with the great infrequency of volcanic eruptions throughout the Mesozoic.

Moreover, it is not absolutely necessary to suppose that the glacial periods were caused by a lowering of the general temperature of the earth's surface, in connection with a reduction of the quantity of carbon dioxide in the atmosphere. The unquestionable occurrence of many glacial phenomena in South Africa, Australia and New Zealand, has suggested the premature conclusion that the glacial periods were general or nearly so. It is very possible, on the contrary, that they were essentially local phenomena, connected with modifications of climatic conditions caused by changes in the distribution of sea and land.

## The Wright Infringement Suit in France

THE Third Chamber of the Civil Tribunal of the Seine handed down an opinion, on the 29th of April last, on the validity of the Wright patents in France. Although the decision is by no means final, it seems that the French courts are inclined to uphold the validity of the Wright patents.

As in this country, the point at issue was not simply the method of warping, but the use to which the vertical rudder is put during the process of warping. It will be remembered that the Wrights never claimed to be the originators of warping a wing in order to preserve lateral balance, but that they did claim to have discovered the necessity of throwing the vertical rudder over to the side of least resistance during warping, in order to prevent the entire machine from swinging around a vertical axis. In the earlier Wright machines, the vertical rudder and the warping devices were operated from a single lever, which was given a kind of elliptical motion in order that the wings might be warped simultaneously with the swinging of the rudder.

The French preliminary decision involved the following machines and makers: Blériot, Koechlin, Clément-Bayard, Antoinette, Farman, Esnault-Pelterie, Fernandez, Les Ateliers Vosgiens, and La Banque Automobile. The court held that the French patent dated March 22nd, 1904, granted to the Wright Company, covered not only the simultaneous operation of the rear vertical rudder and the warping devices, but also the separate operation of the two, so far as that operation was necessary to keep the machine on its course in straightaway flight. The defendants had sought to limit the French assignees of the Wright patent to a mechanism which would simultaneously warp the wings and work the rudder, leaving them free to employ warping devices and rudders which were not interconnected. "In the patent of 1904," said the court, "the action of the warping devices with the rudder operating devices is described so minutely that it can be understood and applied by engineers and aeroplane constructors; there is no reason to believe that the Wright brothers should have claimed their combination more broadly, and should have specifically covered the separate operation of each of the elements. . . . After the patent of 1904, the invention consisted in a method to maintain or re-establish the equilibrium of the aeronautic apparatus, and to guide the machine in a vertical or horizontal direction. Among other elements the patent provided for (1) two horizontal surfaces called wings, constituted by frames on which fabric was spread, and connected with one another by posts and articulations which permitted the movements of flexion and torsion at the ends of the wings in an inverse direction; (2) a vertical movable rear rudder connected with the cable, by means of which the wings were warped. . . . The combination of the two elements evidently falls within the scope of the patent, inasmuch as it is there said (lines 4 to 19, page 3): 'By this means of fixation the same movement of the cables which actuates the end of the wings also presents to the wind that side of the vertical rudder which is turned toward the side having the smallest angle of incidence.'" Continuing, the court remarked that the dissociation of the two elements claimed fell within the scope of the patent of 1904, and that since the independent operation of the warping devices and the vertical rudder was a natural development of the original invention, the patentees or their assignees alone should be privileged to enjoy the improvements made.

In 1907, the Wright brothers took out two other French patents, in which warping devices and vertical rudder operating devices, functioning independently, were described and claimed, but providing that the two elements could be operated together, if necessary. These two patents of 1907 repeat much of what is contained in the patent of 1904, and for that reason the court was inclined to construe the later patents as embodiments of improvements on the original invention.

Convinced though it was that the French Wright patents were valid, and that most, if not all, of the defendant companies were infringers, the court was not inclined to hand down a final decision. It thought it advisable to ascertain whether there might not be one or several anticipations of all the elements described in the patent of 1904, and whether it might not be possible for the defendant companies to show that they could manufacture machines which would avoid the Wright claims. The court felt that it needed expert opinion to assist it in deciding whether or not the Wright brothers were the original inventors of the apparatus in which they made their famous flights in France in 1908. Three experts were appointed for that purpose, Messrs. Leauté, Commandant Rénard and Marcelle Deprez, to ascertain if there were any anticipations of all the elements in the combination described in the patent of March 22nd, 1904, and in the case of a negative result, to determine if the structural parts of the machines of the defendants are infringements of the Wright invention and to be considered as accessory improvements of that invention; or if, on the contrary, there are essential differences between the characteristic elements of the defendants' inventions and that of the Wrights.

## New Researches in Stellar Evolution

PROF. J. C. KAPTEYN, director of the observatory of Groningen, in an address to the Thirteenth Dutch Science Congress, which met in that city in April, has made public some exceedingly interesting facts connected with the delicate researches by which he (simultaneously with Eddington at Greenwich) discovered the dual character of our stellar system.

These facts were discovered in the course of a study of those stars which give the greatest promise of extending our knowledge of the real constitution of the universe. In particular, Prof. Kaptyen made a careful study of the star drifts formed of stars of the same spectral type, especially of the helium stars and the stars designated as types I. and II. These three types form a chronological series, the helium stars being the oldest.

From a comparison of the parts played by these three types in the formation of the two great star drifts of which the stellar universe is composed, Kapteyn finds that, in passing from the helium type to types I. and II., the approximation to parallelism of the drifts diminishes, the direction of motion gradually changes, and the mean velocity increases slightly. These results of observation, in conjunction with other known facts, lead Prof. Kapteyn to the following conclusions:

1. The stars cannot have been formed from planetary nebulæ.

2. The origin of the stars should rather be sought in the spiral nebulæ, our knowledge of which is still so imperfect, and in the irregular nebulæ, such as those of Orion and the Pleiades.

3. All the known facts indicate that the so-called universal force of gravitation exerts no influence upon the primordial matter from which all stars have been produced.

4. The stellar system was not originally a single system in which the two known drifts or currents have developed, but the present system is the result of the encounter of two systems which, originally, were entirely independent of each other.

5. The primordial matter is now more abundant in the drift of less star density and is almost entirely absent from the opposite drift, which is richer in stars.

# The Inventor's Department

Simple Patent Law; Patent Office News; Inventions New and Interesting

## Dr. Alexander Graham Bell's Ice Stove

**Keeping the thermometer at sixty-five**

**By William Atherton Du Puy**

DR. ALEXANDER GRAHAM BELL, inventor of the telephone and many other things, is this summer working on a cold air system of making life in city houses in the summer time endurable. The results of his investigations have been that he has maintained a temperature of 65 degrees in an improvised study in his Washington home, and has luxuriated in this ideal temperature while Congress, Government officials and others forced to remain over in the heat of the national capital have sweltered.

Dr. Bell's refrigerating system is a modification of the "ice stove" invented some years ago by Willis J. Moore, chief of the Weather Bureau. In Mr. Moore's ice stove the process was reversed and ice was fed instead of coal. A current of air was passed through it and into the given living rooms of a house. This cold air had a certain effect in lowering temperatures, but it was found that the cold air soon escaped and the original temperatures returned.

Dr. Bell has just returned from a trip around the world. He has spent a year in uninterrupted travel. In many tropic countries where Europeans and Americans dwell he was surprised to note that no effort was made to reduce temperatures. In none of the houses of the tropics is the temperature less than the normal shade heat. Dr. Bell held that by taking thought this condition might be improved upon.

He returned to Washington just at the beginning of the summer. The ice stove suggestion, coupled with his observations abroad, and a desire to remain comfortably in Washington for a time to look after his interests, led to cold air experiments. He soon decided that, while the ice stove produced cold air, the ordinary apartment was not fitted for retaining it. It is a well-known fact that cold air is heavier than warm air. Everybody has noticed that when a window is opened in a room in cold weather, the feet of the occupants soon feel the cold while the room is still warm higher up. The admitted cold air has fallen to the floor.

More exact experiments prove more conclusively the greater weight of cold air. Cold air may be poured into a bucket and be carried about. It is much like water or any other of the liquids. Being heavier than warm air, however, it has a tendency to spread out as water would unless restrained. So, when cold air is poured into the ordinary chamber, it flows out through the doors, the windows or any other leaks that may exist in the given apartment. All houses are built open at the floor level. They will not retain the cold air. An attempt to keep cold air in them is as useless as an attempt to keep water in a bucket full of holes.

Such were the conclusions which Dr. Bell reached. Then the idea occurred to him of finding a receptacle for his cold air. On the ground floor of his house is what was once a swimming tank. It is built to hold water. He decided that it would hold cold air.

Dr. Bell discarded the original ice stove and arranged a large ice box of his own design. Air pipes lead into this ice box, and lead from it into the bottom of the empty swimming tank. Into this lead pipe is placed an electric fan which regulates the flow of air. When the fan is started it draws air through the ice box and conducts it to the bottom of the swimming tank. The tank is filled with cold air just as it might be filled with water. To be sure a certain amount of the cold air comes in contact with the warm air at the top and is carried away. But a small current constantly coming in from below replaces it, and the room is kept at the desired temperature.

Dr. Bell set the scale of the desirable temperature at 65 degrees. This is regarded as the ideal degree of heat and cold for the well-being of man. He regulated his fan in such a way that it would keep a sufficient current of cold air coming into the room to maintain this temperature. He moved his easy chair, his study table and his couch into the old swimming tank. There he is spending the hot weeks in ideal comfort, while the President of the United States and those dignitaries who make the laws swelter with the thermometer at 90 and above. Once in three days the ice box requires refilling, taking 200 pounds. This and the current required to keep the small fan going is the sum total of the expense of maintaining the cold air plant.

Dr. Bell is succeeding in keeping cool in sultry summer weather in Washington, and that weather is as bad as it is easy to find. But he holds that he is also establishing a principle upon which may be based a practical plan for refrigerating a portion of any city house. He is not patenting any of his appliances in this connection. All the world is at liberty to use the scheme of the ice box and the fan and the water-tight room for retaining the cold air. In almost any house there is some room that may be adapted to the scheme of containing cold air. The manner of its arrangement and fitting to the purpose may be worked out by the given householder. Any man may arrange himself an apartment where he can regulate his climate to suit himself. The expense of this made-to-order climate for an entire summer will be less than a single week's end at a watering resort. Dr. Bell believes that the future will witness a general application of this method of overcoming summer heat discomfort through taking thought.

## How I Invented the Air Brake*

**By George Westinghouse**

MY first idea of braking apparatus to be applied to all of the cars of a train came to me in this way: A train upon which I was a passenger between Schenectady and Troy in 1866 was delayed a couple of hours due to a collision between two freight trains. The loss of time and the inconvenience arising from it suggested that if the engineers of those trains had had some means of applying brakes to all of the wheels of their trains, the accident in question might have been avoided and the time of my fellow-passengers and myself might have been saved.

The first idea which came to my mind, which I afterward found had been in the minds of many others, was to connect the brake levers of each car to its draft gear, so that an application of the brakes to the locomotive, which would cause the cars to close up toward the engine, would thereby apply a braking force through the couplers and levers to the wheels of each car. Although the

* From Presidential Address presented at the Annual meeting of the American Society of Mechanical Engineers.



## INQUIRY COLUMN

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. There is no charge for this service. **In every case it is necessary to give the number of the inquiry.** Where manufacturers do not respond promptly the inquiry **may** be repeated.

**MUNN & CO., Inc.**

**Inquiry No. 9234.**—Wanted a small specialty of merit for office, household or personal use and of universal salability, to sell for from $3 to $25. Proper articles can be financed.

**Inquiry No. 9235.**—Wanted, names and addresses of manufacturers of machinery and appliances for making celluloid.

**Inquiry No. 9236.**—Wanted, the name and address of the firm making the New England Filling Machine.

**Inquiry No. 9237.**—Wanted, information relative to the Parmelee Automatic Aerated Water Still and Sterilizer.

**Inquiry No. 9238.**—Wanted, addresses of those who own deposits of rottenstone, lump pumice, infusorial earth or rubbing stone.

**Inquiry No. 9239.**—Wanted, addresses of parties who can ship ores containing any of the following elements Vanadium, molybdenum, uranium, tungsten, titanium.

**Inquiry No. 9240.**—Wanted, addresses of owners of limestone beds running not less than 98 per cent, and near a railway.

**Inquiry No. 9241.**—Wanted, addresses of owners of deposits of molders' sand suitable for heavy castings.

**Inquiry No. 9242.**—Wanted, addresses of makers of bag valves.

**Inquiry No. 9243.**—Wanted, address of maker of Rover's monogram embossers.

**Inquiry No. 9244.**—Wanted, address of manufacturers making rollers, scrapers, and driers suitable for making soap leaves.

**Inquiry No. 9246.**—Wanted, addresses of parties having raw materials or minerals containing potash in any form.

**Inquiry No. 9247.**—Wanted, to buy a Parmelee aerated water.

**Inquiry No. 9254.**—Wanted, the name and address of manufacturers of lead pencils and pen holders, such as are used for printing advertisements on.

**Inquiry No. 9255.**—Wanted, to buy a patent roller, a ball-bearing axle, which could be purchased on a royalty basis; it must be cheap and fully proved.

crudeness of this idea became apparent upon an attempt to devise an apparatus to carry the scheme into effect, nevertheless the idea of applying power brakes to a train was firmly planted in my mind.

Shortly afterward, while I was in Chicago, the superintendent of the Chicago, Burlington and Quincy Railroad, Mr. A. N. Towne, invited me to inspect what was then considered an ideal passenger train, namely, the Aurora accommodation. I accepted this invitation, and while looking over the train, which was fitted with a chain brake, I was introduced by Mr. Towne to Mr. Ambler, the inventor of that brake. The Ambler brake, as was explained to me, consisted of a windlass on the locomotive which could be revolved by pressing a grooved wheel against the flange of the driving-wheel to wind up a chain which extended beneath the entire train over a series of rollers attached to the brake levers of each car and so arranged that the tightening of the chain caused the brake levers to move and thereby apply the brake shoes to the wheels. I ventured to say to Mr. Ambler that I had been working upon a brake myself, but was immediately informed by him that there was no use working upon the brake problem, because he had devised the only feasible plan, which was fully protected by patents. Mr. Ambler's opinion and advice, however, proved to be an incentive to a more energetic pursuit of the subject.

As an improvement on Mr. Ambler's plan, I considered the use of a long cylinder to be placed under the locomotive, the piston of this cylinder to be so connected to the chain that it could be drawn tight by the application of steam from the locomotive boiler with a force which could be more accurately controlled than was possible with the windlass arrangement. A short study of this idea showed that it would be impossible to have a cylinder long enough to operate a chain brake upon more than four or five cars, whereas trains of ten and twelve passenger cars were frequently run upon the important railways.

My next thought was the placing of a steam cylinder under each car with a pipe connection extended from the locomotive beneath its tender and under each car, with flexible connections of some sort, not then thought out, so that steam could be transmitted from the locomotive through the train pipe to all of the cylinders; but, as in the case of the attempt to improve the chain brake, it required but little time with some experimentation to disclose the fact that it would be impossible, even in warm weather, to successfully work the brakes upon a number of cars by means of steam transmitted from the locomotive boiler through pipes to brake cylinders.

Shortly after I had reached this conclusion, I was induced by a couple of young women, who came into my father's works, to subscribe for a monthly paper, and in a very early number, probably the first one I received, there was an account of the tunneling of Mont Cenis by machinery driven by compressed air conveyed through 3,000 feet of pipes, the depth at the time of that tunnel. This account of the use of compressed air instantly indicated that brake apparatus of the kind contemplated for operation by steam could be operated by means of compressed air upon any length of train, and I thereupon began actively to develop drawings of apparatus suitable for the purpose, and in 1867 promptly filed a caveat in the United States Patent Office to protect the invention. In the meantime I had removed from Schenectady to Pittsburg, where I met Mr. Ralph Baggaley, who undertook to defray the cost of constructing the apparatus needed to make a demonstration.

At that time no compressed air apparatus of importance had within my knowledge been put in operation. The apparatus needed for a demonstration was, however, laboriously constructed in a machine shop in Pittsburg, being finally completed in the summer or early autumn of 1868. This apparatus consisted of an air pump, a main reservoir into which air was to be compressed for the locomotive equipment, and four or five cylinders such as were to be put under the cars, with the necessary piping, all so arranged that their operation as upon a train could be observed. Railway officials of the Pennsylvania and Panhandle railroads were then invited to inspect the apparatus and witness its operation. As a result, the superintendent of what was then known as the Panhandle Railroad, Mr. W. W. Card, offered to put the Steubenville accommodation train at my disposal to enable me to make a practical demonstration. The apparatus exhibited was removed from the shop and applied to this train, which consisted of a locomotive and four cars. Upon its first run after the apparatus was attached to the train, the engineer, Daniel Tate, on emerging from the tunnel near the Union Station in Pittsburg, saw a horse and wagon standing upon the track. The instantaneous application of the air brakes prevented what might have been a serious accident, and the value of this invention was thus quickly proven and the air brake started upon a most useful and successful career.

Prior to the construction and practical test of the air brake, I had opportunities while traveling to present the subject to numerous railway officials and to endeavor to secure their co-operation in the development of the apparatus. None of those approached appeared to have faith in the idea, though I afterward found that the acquaintances made and the many discussions I had had with railway people were of great advantage in the introduction of the air brake upon the railways with which they were connected.

(*To be continued.*)

### Notes for Inventors

**Left-hand Mold Boards for Plows.**—A Patent Office examiner has just returned from a trip to Oklahoma, and remarks on the large number of plows with left-hand mold boards which he saw in use in Southern Ohio, Illinois and Indiana. Although he has farmed much of his life, he is unable to explain why the left-hand mold boards are used.

**A New Talking Machine Record.**—The Phonofilm Syndicate of London is the assignee of a patent, No. 992,169, for a gramophone record and holder in which the record consists solely of an annulus of thin, flexible record receiving material, and this record is combined with a holder which has a backing and means are provided for securing one edge of the record to the holder.

**A New Automobile Horn.**—A horn adapted for automobile use has been patented to Ernest Rubes of Brooklyn, No. 992,259, the body of which is composed of a flexible metal tube with the bell at one end. In more specifically defining the horn, it is said to be composed of a length of flexible metallic tubing having inherent resonant qualities and a vibratory sound-producing device and means for operating such device to cause the sound to pass through the flexible tubing.

**A New Arc Lamp.**—An arc lamp patent, No. 992,479, has been assigned to the General Electric Company, in which the lamp has electrodes between which the arc is formed, and an inclosing globe together with purifying means through which the gases from the arc are conducted and brought back to the arc in such manner as to prevent them from coming in contact with the inclosing globe.

**A Woman's Invention.**—A Dayton (O.) woman, Agnes M. Klin, is the patentee of

a folding paper vessel, No. 992,210, which has a conical-shape portion forming the receptacle, and folds connected to the receptacle and adapted to be folded to form a handle which stands at right angles to the walls of the receptacle.

**Making a Tree Pull Itself Up by the Roots.**—A stump puller has been patented to Harry Gordon of Boise, Ida., No. 992,419, in which a fulcrum is provided alongside a tree and the trunk of the tree is severed slightly below the fulcrum and is harnessed to the stump so that the tree trunk in falling will tilt on the fulcrum and will operate to pull the stump from the ground.

**A New Gathmann Projectile.**—On May 16th, 1911, a patent was issued to Emil Gathmann of New York for a projectile whose body portion has a hardened tapered point on which is mounted a tapered soft metal cap, a hollow wind cap being mounted on the forward portion of the soft metal cap and a reinforce being placed between the wind cap and the soft metal cap.

**Necessity the Mother of Invention.**—He was an inventor from the Middle West with an improvement in farm equipment; but he also evidenced his inventive abilities in other directions. His left leg was paralyzed, requiring him to walk with crutches. He had removed the chain and right pedal from an ordinary bicycle, leaving the left pedal as a rest for the foot of his bad leg, and he propelled the machine by his right leg, pushing the foot against the ground. Thus he was able to go from place to place with facility. His mode of carrying a watch was entirely original. He wore a chain, but the watch, a big silver affair, was not attached to the chain, but carried in a large buckskin purse with an ordinary metal clasp, and the purse was attached directly to the chain. To see the time, he would take out the purse, open it, remove the watch, and after inspecting it, replace it in the purse, close the purse and put it back in his pocket. The whole performance was carried out with deliberation.

**For the Hardware Trade.**—The rapid and enormous increase in the use of potato and beet-root alcohol as fuel is worth utilizing by American manufacturers of articles which could use this material—as, for instance, small cook stoves and portable heating stoves, and flatirons (or sad-irons, an' it please you better) heated by a small internal alcohol burner. There are hundreds of thousands of these made annually; and their convenience in very small households renders their introduction merely a question of the price of the so-called "denatured" or undrinkable alcohol. There is a society in Germany composed of distillers and manufacturers of alcohol-burning devices, which holds permanent exhibitions of such apparatus, offers prizes for the encouragement of the industry, etc.

**An Improved Multiple Unit System of Train Control.**—A patent, No. 992,583, has been issued to the Westinghouse Electric and Manufacturing Company, as assignee of a Havre (France) inventor for an electrically propelled train of a number of vehicles with an engine on each vehicle and generators driven respectively by the engines and propelling motors for the vehicles which motors are supplied respectively from the generators upon the same vehicles as are propelled thereby, and means are provided for controlling the operation of the engines and of the motors from a controlling point on the train.

**A New Edison Patent.**—A patent, No. 993,294, was issued May 23rd, 1911, to Thomas A. Edison, for a device for feeding pulverulent material, which included a number of parallel screw conveyers arranged in different horizontal planes and rotated to cause the material to feed from a receptacle toward a common point.

## NEW BOOKS, ETC.

**Railroad Traffic and Rates. By Emory R. Johnson, Ph.D., and Grover C. Huebner, Ph.D. New York: D. Appleton & Co., 1911. 8vo.; 1000 pp.; illustrated. Two volumes. Price, $5 net.**

Vol. 1 deals with the freight traffic of American roads, its organization and management, its classification and tariffs, the sources whence it comes, and its volume and earnings. By the use of graphic charts the increase in traffic during recent years is shown in a striking manner. Passing to the question of management, the organizations of prominent systems are given in detail, including the personnel of special staffs maintained for the purpose of increasing the productivity of industries served by the company and of attracting new industries to its support. Emphasis is laid upon the fact that a railway must make thousands of rates in which tens of thousands of individuals have a vital interest. Upon these rates and services depends the health of the business activities of the nation. The delicacy of the situation cannot be ignored. Officers of the company can no longer regard theirs as a private enterprise, but are coming to realize more and more how indissolubly their prosperity is bound up with that of the interests they serve. "The better the transportation service the more substantial is the basis for larger gross earnings." In the chapters which consider freight forms and accounting, facsimiles of bills of lading, stock contracts, waybills, tracers, daily reports and records, and even deposit slips, are shown, with a full explanation of their uses and advantages. Car service and efficiency is given extended study, the machinery of rate making is exhibited in action, and import and export rates are explained and charted. The chapters containing material of a technical nature were all read, criticised and corrected by traffic experts. Vol. 2 deals with passenger, express and mail services. Here again forms, maps and charts aid the text in conveying a maximum of information in a minimum of space. Passenger tickets of the early days are contrasted with those of the present and the verbiage of the excursion ticket is made plain. Methods of accounting are given considerable space. The baggage service is fully treated and its rules and forms adequately presented. Illuminating chapters follow on the development of passenger traffic, electric and steam railroads, express companies and carriers, and the railway mail service. This is an admirable work, and its value to railway men and to students can scarcely be overestimated.

Railway Problems. Edited with an Introduction by William Z. Ripley, Ph.D., Professor of Economics, Harvard University. New York: Ginn & Co. 8vo.; 686 pp.

The first part of the volume is devoted to reprints of papers such as Charles Francis Adams's "Chapters of Erie," and Ida M. Tarbell's "Standard Oil Rebates," and to reports of cases such as those of the St. Louis Business Men's League and the Dawson and Danville contests over the Southern rating systems. Prof. Ripley admits that this is throwing infamous events into high light to the exclusion of the great mass of solid pioneer work done by the railroads; but in a work aiming at the betterment of existing conditions this reviewing of the darker side is obligatory. His view of the present and of the future is optimistic. The enactment of Federal legislation has shown the quickening of the public conscience, and a further extension of public regulation is urged. At the same time, Prof. Ripley would re-establish the pooling system under government supervision, believing that it would lead to stable rates and result in more direct routing, with all the increase in efficiency and economy that such simplified conditions imply. This is a recognition of the fact that railroads, unlike industrial combinations, are essentially natural monopolies, and should be treated as such. The pooling system would still permit of healthy competition, not by rate-cutting or secret rebates, but through the extension of better service and facilities. In the third division of the work, the subject of government regulation is given a thoughtful discussion, and the great underlying principles of constitutional law as defined by the Federal Courts are shown in the making. European ways of handling railway problems are gone into to some length, and their adaptability or non-adaptability to American conditions is pointed out. It is Prof. Ripley's conclusion that our transportation system is the best in the world; but, as he says, that is no reason why it may not be improved upon in some particulars by the adoption of European ideas.

Scientific Management and Railroads. By Louis D. Brandeis. New York: The Engineering Magazine, 1911. 8vo.; 92 pp.

The name of Louis D. Brandeis will be recalled as that of counsel for the Traffic Committee of the Trade Organizations of the Atlantic Seaboard, in the recent investigation into the proposed freight rate advance. Mr. Brandeis would substitute competition toward efficiency for that declining form of

competition which until recently made for progress. He offers the pursuit of conservant efficiency as a cure and a substitute for what he justly terms a vicious cycle of increasing costs and increasing prices. His contention is that the institution of scientific management on American railroads would result in an aggregate saving of at least a million dollars a day. The volume in hand—a part of the brief submitted before the Commission—attempts to refute the railroads' statement that the possibilities of economy in operation have been exhausted, and gives his own solution of the question in a series of well-written arguments and suggestions. Specific instances are given in the applicability of this modern movement to railroads, in the maintenance of equipment and of way, and in transportation.

RAILROAD ADMINISTRATION. By Ray Morris, M.A. New York: D. Appleton & Co., 1910. 8vo.; 309 pp. Price, $2 net.

The editor of the *Railway Age Gazette* gives the non-technical reader a view of the manager's problems in railroad organization and operation. There are no dull lines in the work. The statements come sharp and clear as the crack of a gun on a frosty morning. We are at once initiated into the mysteries of construction—the headquarters staff, the field staff, diplomacy *versus* the right of eminent domain, and all the numerous obstacles to be surmounted before the new line is finished and turned over to the operating organization. A diagram of this operating organization in its broadest, simplest form will show the outline of an hour glass. At the top are the stockholders, who elect directors, who in turn appoint a president. The president's powers are directed and diffused through vice-presidents, the general manager, and superintendents, until they guide and control the lower units of the organization. In practice, of course, the problem is much more complex than the above superficial statement would imply: it is in presenting these complexities and showing the ways in which they are met and handled that Mr. Morris discloses his practical knowledge and that rarer faculty of conveying the knowledge to others in simple and attractive language. Plentiful diagrams clearly demonstrate the apportionment of authority and responsibility—a vital consideration. In the chapter on the public relations of a railroad much is done to clear away misunderstandings and alleviate friction between the road and its patrons. Tendencies of development are reviewed, as affected by combinations, traffic resources, labor conditions, and popular demand. Nothing but good can come of the public and the railway getting into closer touch. When the people come to realize what a splendid achievement successful railway administration is, they will be more sympathetic and lenient toward hardly preventable shortcomings. At the same time their new knowledge will enable them to discriminate between the faults inherent in all human systems and the deliberate impositions and extortions of a monopolistic body toward those whom it was created to serve.

OUR HOME RAILWAYS. How They Began and How They Are Worked. By W. J. Gordon. Two volumes. New York: Frederick Warne & Co., 1910. 8vo.; illustrated. Price, $4.50 net.

This is a well-written, sumptuously illustrated story of British railroads, and it will prove engrossing reading to all who like to hear how man has struggled to bend the laws of nature to his will. The first volume has no less than three hundred illustrations from photographs and thirty-six colored plates. It takes the seven great railway systems of England, one after another, and gives their origin, history, and development down to the present day. Early times were stirring times, no less than those we are living in—times of the broad gage *versus* the narrow, slipping clay *versus* chain-loaded piles, the estuary tunnel *versus* the tidal wave—until the mere physical constructions were conquered and the guiding minds left free to develop the railway along the lines of capacity, comfort, and speed. Then come the marvels of the locomotive shops—the hydraulic riveter, the drilling machines, the flanging presses; the engine-testing pit, where new engines are speeded up to eighty miles an hour without advancing an inch, while measurements of speed and power are taken, fuel and water consumption accurately noted, wastes weighed, and the developed power utilized at the same time to drive an air compressor that supplies the pneumatic tools. There is the Midland Railway, whose capital is one-fourth the amount of the National Debt. This company has perhaps done more for British advancement than any other. It was the first to carry coal, the first to run an excursion, the first to make the third-class carriage comfortable. There is the London and South-Western, which must be credited with the first trial of automatic signalling, to whom is due the invention of the Mansell wheel; whose Plymouth mail is fitted with real beds instead of shelf berths, and which has steadily improved upon its rolling stock until it is surpassed by none.

### The Interstate Commerce Law

(Continued from page 586.)

practical questions have arisen and been presented to the commission by both carriers and shippers without waiting for their presentation in a formal proceeding. In this practice there has grown up what may be not improperly termed a code of rules, regulations and conference rulings, which is of great practical value and assistance to the commission, the carriers and the shippers alike, and which has been manifestly effective in the elimination of vagueness and ambiguity in tariffs and the erroneous and unlawful application of their provisions in many ways formerly practised.

To the extent that a better enforcement of the law has cut out rebates and unlawful concessions in other forms its result has been doubly beneficial. It has promoted equality among shippers and conserved the carriers' earnings to an important extent.

The full attainment of the beneficent purposes of this law depends in great measure upon the co-operation of every carrier and shipper with the commission, and it is a cause for patriotic congratulation and satisfaction that the viciousness of offenses in violation of the penal inhibitions of the law is being more and more realized as its just purposes are coming to be better understood, and that it is no longer lightly regarded that the shipper may without loss of character and with impunity solicit unlawful favors and advantages from the carrier or that the latter may with impunity grant them. Both must realize that when they obtain money by violations of law they pay more for it than it is worth.

### Relations of the Railroads to the Public

(Continued from page 587.)

benefit by railroad extension in that the increasing population following in its wake will multiply domestic markets, and domestic are preferable to foreign markets. The population of this country increased nearly 16,000,000 in the decade from 1900 to 1910, and in that increase the railroads were perhaps the most important factor. They made remote lands accessible, the disposition of their products practicable, and enabled the distribution among their inhabitants of the products of our factories.

This addition to our population during ten years is almost as great as the population of Mexico and the five Central American States combined, and its consuming capacity is far greater. If we had acquired the exclusive trade of Mexico and these five Central American States, or the entire trade of Chile, Peru, Bolivia, Venezuela, Ecuador, Uruguay, and Paraguay, the combined population of which is not quite 16,000,000, we should not have obtained the same advance in our commerce as has been provided by the increase in our own population during these ten years.

We should reflect that by opening up new and improving our existing railroads we can provide for the needs of a population twice as great as we now have and our country would still be sparsely settled in comparison with that of other prominent nations. For example, the German Empire has in Europe a population of 63,066,000 in an area of 208,830 square miles. Our population exceeds that less than 50 per cent, while our area is more than fourteen times as great.

We not only need new railroads, but every railroad in the United States is in constant need of extensions and improvements. The demands of an increasing traffic are forcing betterments of all kinds, in equipment, in track, in stations and warehouses, better facilities for everything that a railroad does. Every railroad manager has plans for extension and improvement that are postponed from year to year. It will not do for the people of this country in measuring the prosperity of the railroads to say that a current rate of profit less than is yielded by other investment, is sufficient. The people must realize that the railroads must provide for the future, and if the progress of this country is to continue,

must co-operate with them in making that provision.

## The Transcontinental Railroads of Canada

(*Continued from page 593.*)

The undertaking owes its inception entirely to the bold, progressive policy of Mr. Charles M. Hayes, the president of the Grand Trunk Railway system, who conceived the idea during the short period he was in charge of the Union Pacific for Mr. Harriman. When the scheme was submitted to the Canadian Government for approval and support it was warmly supported, and tangible financial assistance was promised. The Government, however, in deference to public opinion, undertook to construct and retain one-half of the line, subsequently leasing it to the Grand Trunk Pacific Railway for a term of fifty years at a rental equivalent to 3 per cent on the constructional cost, such interest, however, to be waived for the first seven years, while the country traversed was being settled and developed, the company undertaking to defray maintenance expenses during this period only. On the mountain section, which is perforcedly the most difficult from the engineering point of view, and consequently the most expensive to build, the Government is contributing to the cost to the extent of 25 per cent.

When the scheme was sanctioned it was decided that construction should be carried out upon a high standard, in accordance with the requirements of a modern railway to meet the exigencies of heavy fast traffic for several years to come, thus avoiding that realignment and reconstruction which is so severe a burden upon American railways to-day. For this reason it was stipulated that the ruling grade should not exceed four-tenths of 1 per cent per mile against east and west bound traffic, and that curves should not be sharper than five degrees. Timber trestles also were to be omitted, unless it was intended that such should be afterward filled in to form a stable embankment.

The Government section is 1,804.84 miles in length, and extends from Moncton in New Brunswick, which is the Atlantic seaboard terminal, to Winnipeg, the Grand Trunk Pacific carrying the construction through from the latter point to Prince Rupert, on the Pacific coast, a distance of about 1,785 miles. It was also stipulated that the line should run entirely through Canadian territory, which restriction compelled the surveyors to make a wide detour around the north of the State of Maine.

The railway is to be carried across the St. Lawrence River about four miles above Levis. After leaving Quebec the line rises sharply and strikes in a north and northwesterly direction through the heart of the province of Quebec, until it crosses the 48th parallel, keeping on the northern slope of the "Divide" all the way to Winnipeg. The construction of the line through Quebec and Ontario has bristled with difficulties, the greater part of which, however, were in regard to the sending forward of supplies and material. The road, 100 feet in width, has been cleared the whole distance between Winnipeg and Quebec, some 1,344.39 miles, and the grading is well advanced toward completion.

Westward of Winnipeg the Grand Trunk Pacific has completed and inaugurated its service upon the 793 miles of line to Edmonton. This section is laid over the rolling prairie, with the result that grades and curves are of the easiest description.

The prairie section extends for 126 miles west of Edmonton to Wolf Creek, a tributary of the MacLeod River. This point is the official commencement of the mountain division, as the section to the coast is called, inasmuch as it has to negotiate the Rockies and the coastal continuation of the Cascades. At Wolf Creek the track is at an elevation of 2,700 feet above the sea level, and yet the highest point reached by this railway is only 3,720 feet in the Yellowhead Pass where the Rockies are traversed. The Pass, however, is about 100 miles west of Wolf Creek, and from the latter point the grade rises steadily and continuously the whole distance, but only on an aver-

age of 10 feet to the mile, which ascent is almost imperceptible.

Though the railway cannot offer such examples of spectacular engineering as the Rockies in Montana and Colorado, yet the greatest achievement lies in the avoidance of these very obstacles, so as to provide an almost level route, with no stiffer grades and sharper curves than are to be met on the open prairie. To railway operation this is of far-reaching value. For instance, a locomotive of the consolidated type weighing 107 tons would haul on a perfectly level track 3,868 tons. On a 1 per cent grade, however, it could handle only 810 tons; but on a four-tenths of 1 per cent grade, such as is provided on the new transcontinental line, its hauling capacity would be almost double—1,596.

The western terminus of the line is at Prince Rupert, where there is a magnificent natural harbor varying from three-quarters to one and a half miles in width by ten miles in length, which, varying from 160 to 600 feet in depth, with an unobstructed entrance three-quarters of a mile wide, is considered the finest harbor north of San Francisco.

That this railway is destined to exercise a far-reaching influence upon the movement of traffic across Canada, owing to its easy grades and curvature and closer proximity to the Orient, is admitted on all sides. Moreover, its physical conditions, combined with substantial construction, will render it the fastest line between Atlantic and Pacific. Its economic importance is also incalculable, as it traverses a country which is new, and the resources of which are practically untouched. In British Columbia a virgin territory, rich in mineral, timber, and possessing excellent stretches of agricultural land, is being opened up, and the route cannot fail to have considerable influence upon our trade with Alaska, to which it will be the obvious highroad, linking it directly with our manufacturing and industrial centers, and involving a sea passage to Skagway of only about 500 miles.

### The World's Greatest Railway Terminal

(*Continued from page 595.*)

is estimated that 70,000 outbound passengers can pass through the terminal in an hour, which is double the maximum carrying power of any passenger station existing to-day.

The great train capacity of the station, estimated at a maximum of 200 trains an hour, is due to the introduction of the loop system, both for express and suburban service. Instead of trains coming in, discharging passengers and backing out, they will continue on, when empty, around a loop underneath the southerly front of the station, and then run over to the yard at one side of the station yard, where they will be cleaned and made ready for the next trip. No longer will the trains be run out through the Park Avenue tunnel to Mott Haven for cleaning and making up, and the four tracks through the tunnel will be left entirely free for the service of the incoming and outgoing traffic.

Not only has electricity rendered possible this underground and entirely-inclosed station, but it has cut out a large amount of switching and has been called into service in the installation of an all-electric signal system, which is one of the latest and most perfect to be devised. An interesting detail of the signal system is the fact that, when the gate to the train platform is closed, its shutting gives an electrical signal, not only to the trains, but to the signal towers clear up the main line—an arrangement which will save minutes of time over the old system.

We doubt if, anywhere on earth, there can be found such a busy center of city and railway traffic as that represented by the intersection of Forty-second Street and Park Avenue, where the entrance to the Grand Central station is located. Passengers arriving in New York will find themselves in immediate touch with half a dozen or more separate lines of transportation, either by elevated railway, surface car or subway, by which any section of Greater New York may be reached, frequently without change of cars. Running past the entrance at street

level are the surface cars of several of the main lines of travel north and south through the avenues and east and west by the streets. Above these is a branch of the elevated system which puts the passenger in touch with the east side elevated roads throughout the length of Manhattan and the Bronx. Immediately below the street is the Interborough subway. Below that will be the new subway connecting with the Hudson and Manhattan tubes, by which passengers and their baggage can proceed direct to the terminals of the western railroad to Jersey City; and below that again is the Belmont tube leading beneath the East River to Brooklyn. Passengers will be able to proceed by broad footways direct from their trains to any one of these three subways, or to the surface cars and the elevated trains.

We close our description with a few statistics which cannot fail to be of interest. The total area of the old terminal was 23 acres; that of the new will be 70 acres. The old terminal had a capacity of 366 cars, the capacity of the new will be 1,149 cars. The station building proper will be 600 feet long on street level, 300 feet wide and 105 feet high. Below the street level it will be 745 feet long, 480 feet wide and 45 feet deep. The main concourse will be 120 feet wide and 100 feet high. Eighty-five thousand tons of steel will be used in the construction of the new terminal.

### Hygroscopes

(*Continued from page 590.*)

precious stones, and sometimes to glorify pieces of plain glass so as to make them appear like gems. This foil consists of very thin silver or copper, colored on one side with a kind of varnish. I find that designed to imitate the sapphire does very well. If is of a fine blue color. Three small slips are cut off by scissors (not a knife or the varnished part will peel off), these strips are then twisted round a wire until they resemble ringlets or shavings, as shown in the sketch (of course the wire is slipped out). These ringlets are supported as shown, and a needle set in the baseboard and running up the hollow center of each serves to keep it roughly in place, and to prevent breaking by accident. Three little paper flags are attached as shown, having on one side the letters DRY, and on the other WET. It will be found that these flags turn round instantly when the air becomes damper or drier—indeed they will turn on the approach of a moist hand, or when they are ever so lightly breathed upon, and the strange thing is that they go back just as quickly when the damp stimulus is withdrawn. A wire stretched across the frame prevents the flags from going beyond the position where the letters are most visible. The spiral slips are fixed by seccotine at the top to small pegs, which can be turned round for adjustment when required."

A very popular kind of hygroscope—said to have been introduced by Woodbury in 1871—consists of paper treated with a strong solution of chloride of cobalt, to which is added chloride of sodium and gum arabic. It is blue when dry, but changes gradually toward pink with increasing humidity. It is made in a great variety of forms—sometimes the hygroscopic portion represents a flower, sometimes a woman's dress, sometimes a chameleon, whence the popular name "chameleon barometer." (Fig. 7.) A scale of tints is often added, with the designations "fair," "variable," "rain," etc. Of course this device is a "barometer" only in popular parlance; scientifically it is a *chemical hygroscope.*

### The Railroad Man and His Watch

IT may be news to many that the watch of the railroad man is as necessary in modern railroading as the air-brake. Without accurate time keeping there would probably be more accidents than if there were no air-brakes. The train dispatcher starts a train at a certain time; he halts it at certain stations at certain times; he sidetracks it for a period of varying length; the watch of the conductor on the sidetracked train must agree with the watch of the conductor on the express to which he had to give way; each station master along

the road checks the time of every train that stops or flies past.

In order that there may be agreement among all these railroad men there must obviously be not only timepieces, but accurate timepieces. There must also be some means of inspecting the timepieces to see if they are accurate, and if they agree with some standard. The railroad man is therefore compelled to buy not simply an ordinary watch of reasonable value, but a particularly good watch, a timepiece which is known in America as the seventeen-jeweled patent regulator, a watch which is adjusted to heat, cold, and at least three positions. These three positions are pendant up, as carried in the pocket, dial up and dial down. Such an instrument will not vary more than thirty seconds a week, which is a good deal more accurate than many scientific instruments of precision used in laboratories. Even human proneness to error is considered in this matter of choosing a good railroad watch, for a lever-set watch is preferred to the pendant-set watch because there is just the chance that the stem of the pendant-set may not be pushed back after setting, through an oversight.

On one great line about 5,000 watches, worth on an average of $25 apiece (a low estimate) are used. If we take into consideration the number of watches that are used on other roads throughout the country, it is evident that the value must run up into hundreds of thousands of dollars.

In order that the watch may be kept up to a regular standard, it must be inspected regularly. There is not only a general time inspector on most railroads, but a staff of local inspectors who are placed along the road at convenient points, and to whom the men may resort when they wish to compare their time with the standard time at that place. Once every two weeks the railroad man submits his watch to such an inspector (usually a jeweler or watchmaker by profession). The inspector gives his expert opinion on the condition of the timepiece. If it needs cleaning, he says so and does it; if it is fast or slow he regulates it, and not until it is running with sufficient accuracy is it allowed to escape from his care. A watch's record is kept as if it were a thief. So far as repairing goes, the railroad man is under no compulsion. He need not hand over his watch to any particular watchmaker, or inspector, for repair, but he can give it to any watchmaker in whom he has confidence. It must, however, be submitted to the inspector before it can be used in actual service.

That no favoritism is shown in the matter of watches is evident in the fact that no less than eight different manufacturers supply railroad watches.

### Plants Breaking up an Island.

THE layman would scarcely associate great strength with so delicate and fragile a thing as maidenhair fern, yet if its roots have not sufficient room they will break the pot in which the plant grows. Blades of grass will force the curbstones between which they spring up out of their place, and in a single night a crop of small mushrooms has been known to lift a large stone. Indeed, plants are on record as having broken the hardest rocks.

The island of Aldabra, to the northwest of Madagascar, is becoming smaller through the action of the mangroves that grow along the foot of the cliffs. They eat their way into the rock in all directions, and into the gaps thus formed the waves force their way. In time they will probably reduce the island to pieces.

### What Becomes of the Old Parchments?

OLD parchments of all descriptions always fetch good prices. Dealers have invented a process for removing the ink, and eventually the cleaned parchments in many cases come back as "fine French kid gloves."

The clippings remaining when the gloves are made are not wasted. Mixed with vellum and bits of leather they are boiled down for "size." The coarse shavings, with odds and ends of seal and other skins, are utilized for filling cheap tennis balls.

## Aeronautics

**Aeroplane Accidents and Fatalities.**—Accidents with aeroplanes, quite a few of which are fatal, continue to occur almost daily. On June 1st Marcel Pennot fell in a Curtiss type biplane at Havana, Cuba, and sustained injuries to which he succumbed four days later. On June 2nd, at Versailles, France, M. Gaubert, while making some trials of a new aeroplane, fell and fractured his hip. The same day, at Rio Janeiro, Senor Querez fell some 500 feet and received injuries from which he died two days later. On June 8th Signor Morra, an Italian aviator, was instantly killed by a fall from a height of 300 feet at Rome. On June 4th, at Mineola, William Haupt crashed into a wire fence with his Blériot monoplane when alighting, demolishing the machine and receiving some slight injuries.

**Flying at Rate of 155 Miles per Hour.**—A rather incredible report has been received, stating that aviator Vedrines, while flying from Paris to Rome, covered the distance between Dijon and Macon—77½ miles—in 30 minutes. This is at the rate of 155 miles per hour, and, if correct, means that Vedrines was flying in a wind of 85 to 90 miles per hour. When one considers that Pierre Marie and Lieut. Dupuis were upset and killed when attempting a flight in a 43-mile wind on May 16th, the performance of Vedrines, as cabled to America, is truly astonishing. He was so badly tossed about by the gale which prevailed at the 3,000-foot level that he descended, and his monoplane was smashed in alighting. He was therefore obliged to abandon the Paris-Rome-Turin race. Two other aviators—Frey, on a Morane, and Vidart, on a Deperdussin monoplane—succeeded in reaching Rome last week, so that there are four to finish the race on June 10th.

**A College Balloon Race.**—The first college balloon race to be held in this country was started from North Adams, Mass., on June 3rd, under good weather conditions. Williams, Dartmouth, and the University of Pennsylvania competed with the balloons "Stevens No. 27," "Boston," and the "Philadelphia II.," respectively. The "Boston" landed at West Pelham, Mass., 41 miles from North Adams; the "Stevens No. 27" at Paxton, Mass., 66 miles from the starting point, after 4 hours and 53 minutes in the air, and the "Philadelphia II." at West Peabody, Mass., 115 miles away, after a trifle over 7 hours in the air. This balloon was piloted by Arthur F. Atherholt, an experienced balloonist of Philadelphia, who had George A. Richardson as his aid. They landed in the woods during a heavy thunder storm at 10:30 P. M. The greatest height reached by the "Philadelphia II." was 1,200 feet above Fitchburg. The race was a decided success, and will no doubt stimulate interest in aeronautics among college men.

**Our Backwardness in Aeronautics.**—The launching of the largest dirigible in the world in England last month has called attention to the backward state of our country in aeronautics. With the small appropriation for aeroplanes granted a short time ago by Congress, the War Department is able to do little toward a proper equipment of heavier-than-air machines even, let alone filling our needs as regards lighter-than-air craft. England is making a great effort to catch up to France, Germany, and Russia, especially in the dirigible balloon class. In comparison to her new gigantic dirigible we have only the small one supplied by Capt. Baldwin several years ago. When our two or three aeroplanes are compared with the fifty to sixty machines of all types owned by the French government, we are scarcely worth mentioning. It is interesting to note that while France and England are experimenting so actively with aeroplanes and dirigibles, our government has just opened a balloon school at Fort Omaha, Neb., where there is a special hydrogen-generating plant for making gas by electrolysis. On May 24th Capt. Chandler, accompanied by four of the sixteen students, made an ascension and landed in Iowa. The balloon was equipped with a wireless telegraph outfit and received messages from Fort Omaha.

## Engineering

**Erecting Gatun Lock Gates.**—Material for the gates of Gatun locks is being delivered at the Isthmus. There will be 92 leaves, two to a gate, which will be 7 feet thick, 65 feet wide and will range in height from 37 feet 4 inches to 82 feet. The total number of the locks will be 92, and they will weigh over 50,000 tons.

**Two Dreadnoughts for Chili.**—According to cable dispatches British builders have obtained the contracts for two 26,000-ton battleships for Chili to be named the "Libertad" and "Constitucion." It is stated that each ship will carry twelve 13.5-inch guns—though how they are to do it on the given displacement is to us, we must confess, a mystery.

**The Big Slide at Panama.**—Although the slides at Panama are formidable they will not delay the ultimate completion of the whole work. The largest slide lies on the west bank of the Culebra cut, and from it during the past year over 2,000,000 cubic yards of material were removed. It is estimated that about 2,000,000 cubic yards more will have to be taken away before the natural stability slope is reached.

**The Krupp Aerial Torpedo.**—The Krupp aerial torpedo, which is self-propelling, can be fired from an aeroplane without disturbing the aeroplane's stability. A torpedo carrying six pounds of explosives has covered a range of 5,000 yards. The torpedo is driven by the gases of a slow-burning powder charge which issues through tubes at the rear. The gas tubes are set at an angle which gives a spin to the torpedo.

**Reduction-gear Turbines.**—The two colliers, the "Neptune" and the "Jupiter," each to be driven by turbine engines, which are being built for the United States navy, will carry between turbine and propellers two different forms of reduction-gear. The "Neptune" will have the Westinghouse mechanical gear and the "Jupiter" will have an electric speed-reduction drive. In the latter the turbines will drive generators whose current will in turn drive motors on the propeller shafts.

**The New Armor Plate.**—The Simpson armor plate, of which we hear so much to-day, is broadly similar to the old compound armor plate, which was formed by welding a hard steel face upon a soft steel or iron backing. The armor was imperfect, the face breaking away from the backing when struck by a projectile. Simpson secures a bond by welding a thin plate of copper in between the two layers of steel. A 25 per cent superiority is claimed over Krupp armor, this being due to the thicker face that can be welded on by this process.

**Tunnel 1,100 Feet Below the Hudson River.**—The Catskill water supply will be carried below the Hudson at Storm King in a tunnel bored through solid rock at a depth of 1,100 feet below the surface of the river. The vertical tunnels on each shore have been sunk to the 1,100-foot depth, and the boring of the horizontal tunnel to connect them is in progress. To determine the character of the rock, inclined bore holes were driven from each side to a depth of 900 feet, and below them other bore holes were driven to a depth of 1,500 feet below the river surface.

**Accidents on Railroads.**—The Quarterly Accident Bulletin just published by the Interstate Commerce Commission for the months of October, November and December, 1910, shows that there were 248 persons killed and 3,729 injured in train accidents. Accidents of other kinds bring the total number of casualties not including "industrial accidents" up to 2,659 killed and 19,927 injured. Of this number there was a total of 935 employees killed and 13,882 injured. There is a total number of 60 killed and 877 injured in coupling and uncoupling cars and engines. Accidents reported by electric lines and on which interstate traffic is carried show that there were 114 persons killed and 1,031 injured on electric roads. Of the total number of "industrial accidents," those sustained by employees where no moving engine or car was involved were 107 killed and 20,394 injured. Of the 248 persons killed in train accidents, 30 were passengers; and of the 3,729 injured, 1,601 were passengers.

# The American Merchant Marine

## *THE JULY MAGAZINE NUMBER OF THE SCIENTIFIC AMERICAN ISSUE OF JULY 15th, 1911*

When you were on your trip to Europe last year, or to the Orient, or elsewhere on the "Seven Seas," you were amazed and humiliated to visit port after port and see not a single ship flying the American flag. Flags of Great Britain by the score, and of Germany, France and Norway; but you looked in vain for the Stars and Strips fluttering over the taffrail of the multitudinous shipping of the high seas—and you asked "Why is this?"

The answer will be given in the mid-month issue of the Scientific American of July 15th, the greater part of which will be devoted to the great national problem of upbuilding our rapidly-declining American merchant marine

The subject has its political and economical, as well as its technical side, and the various phases of the problem will be treated by some of the most eminent authorities in the United States, men who are thoroughly conversant with the causes which have led to the decline of American shipping, and who, because of their broad outlook, are eminently qualified to prescribe the best methods for resuscitation.

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The Secretary of the Department of Commerce and Labor, Hon. Charles Nagel, will contribute an article on existing conditions and the best policy to be pursued in bringing our merchant marine up to a standing which will be commensurate with our vast seaborne commerce, and our leading position in the commercial world.

The Commissioner of the Bureau of Navigation, Hon. E. T. Chamberlain, will give an historical sketch of the birth, rise and decline of our merchant shipping, touching upon the causes both of its prosperity when we were a leading nation in the deep-sea carrying trade, and of its decline after the period of our Civil War.

The Hon. William Sulzer, member of Congress, and author of the present bill for restoring the merchant marine, will show that of the three proposed remedies, namely, Subsidies, Free Ships, and Preferential Duties on freight carried in American ships, the last-named is the best and only remedy for existing conditions.

The major portion of the extensive and lucrative maritime trade of the South American republics, by virtue of geographical and other reasons, should come to the United States. One of the most effective agencies in promoting this trade would be the creation of a fleet of fast American mail steamers, to ply between this country and South American ports. An article on this subject will be contributed by the Hon. John Barrett, Director-General of the Pan American Union.

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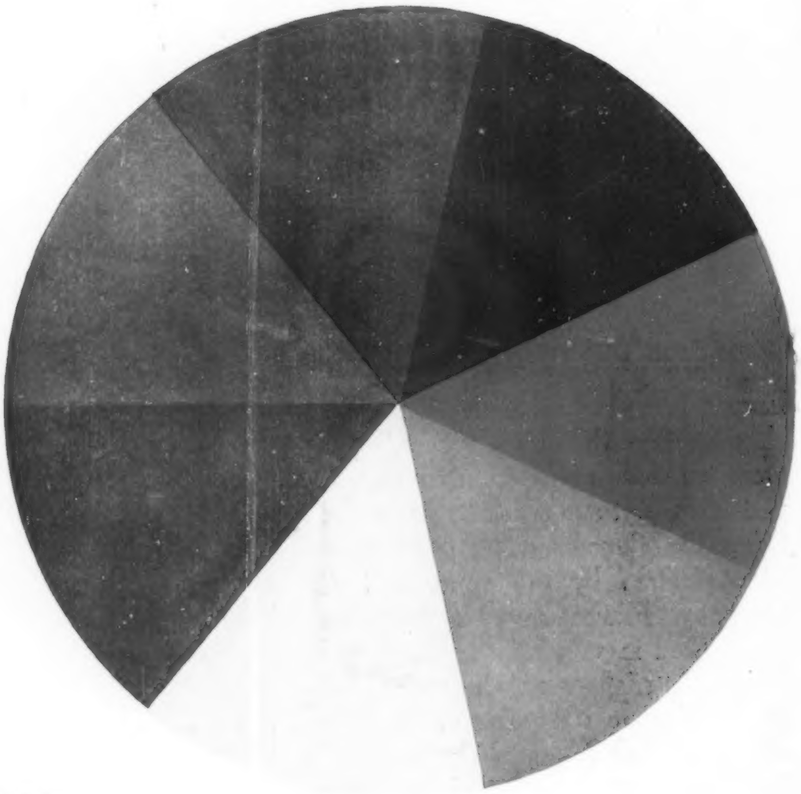
Our battleship fleet could never have accomplished its famous trip around the world if it had been obliged to depend on our own merchant ships to carry the coal required for filling the bunkers of our vessels at the various ports of call. Were war declared to-morrow, our battleships, because of the dearth of colliers, would have to conduct their operations within easy reach of home ports. Naval Constructor T. G. Roberts will show how essential to the efficiency of our navy is the possession by the United States of a fleet of merchant ships large and fast enough to furnish the necessary vessels to carry coal, transport troops, and render other auxiliary service.

Of exceptional interest and value will be an article by Mr. W. A. Dobson, the well-known naval constructor of the William Cramp and Sons Ship and Engine Building Company, in which it will be shown how an ocean freight and passenger steamer is designed and constructed. The writer will explain how the dimensions, form of hull, engine power, etc., are worked out by the naval constructor, and will describe the progress of the vessel from the laying of the keel plate to the final steam trials.

The leading maritime nations have always recognized the importance of port and harbor facilities in promoting ocean trade. Our principal ports, in spite of recent improvements, are many of them without wharf and freight-handling facilities commensurate with the trade that enters and leaves them. Dock Commissioner Calvin Tomkins will contribute an article on the port of New York, in which he will outline a comprehensive plan for terminal improvements capable of accommodating the enormous growth in traffic which must occur during the next half century.

In addition to the above articles, the July 15th issue will contain the usual editorial, aviation, inventor's, and other weekly departments.



# The Truth About Orthochromatism

WHAT ORTHOCHROMATIC QUALITY IS. In the earlier days of photography the plates used gave very untruthful renderings of *color values*. Yellow and red, for instance, photographed as black, while violet, indigo and blue photographed as white. The chart above shows the range of the spectrum from violet to red. The ordinary plate is highly sensitive to violet, a trifle less sensitive to indigo, and so on, until, as we approach the other end of the spectrum, the yellow and orange rays affect the plate but little and the red rays hardly at all. An orthochromatic plate or film is one in which these errors have been so far corrected as to give truer color value, i. e., the emulsion is sensitive to a wide range of colors in an equal or nearly equal degree.

WHY IT HELPS. With a non-orthochromatic plate you might be making a picture, with say a bed of flowers in the foreground—some light yellow and others dark blue. The negative, owing to its deficiencies, would give a print in which the yellow flowers would appear darker than the blue ones, though, to the eye, the yellow flowers would appear lighter. In other words, it would not give, in the resulting pictures, the true color values. The fully orthochromatic plate or film corrects these mistakes and renders the color *values*, (the depths of color) in their proper relation to each other. In the same way the orthochromatic film helps preserve cloud effects, differentiating between the clouds and the surrounding blue sky.

DEGREES OF ORTHOCHROMATISM. There is no difficulty, in factories such as ours, in making any desirable degree of orthochromatism. We make many brands of orthochromatic plates and make them not only in Rochester, but in Toronto, in Harrow, England, and in Melbourne, Australia. It would not, however, be practical to make them all orthochromatic or color sensitive in the same degree. For instance, we make one plate called the "Panchromatic" which is used mostly by engravers in preparing for three color process work. This plate is so sensitive to red that not even the usual ruby lamp can be used in the dark-room. It must be developed in absolute darkness. It is quite evident that such a plate would not be practical for ordinary purposes.

Kodak film was first made as an orthochromatic film in 1903. Up to that time we had literally sold hundreds of thousands of orange dark-room lamps in our developing outfits. Immediately it became necessary to substitute a deep red for orange because this orthochromatic film was so sensitive to yellow.

PRACTICAL ORTHOCHROMATISM. As the largest manufacturers of dry plates in the world, as the largest manufacturers of orthochromatic dry plates in the world, to say nothing of our being the largest film manufacturers in the world, we have, at our command, every advantage that experience and scientific research can give. We know to what degree and for what colors the film should be orthochromatised in order to give the best possible average results in the hands of the Kodaker.

For eight years, Kodak N. C. film has been an orthochromatic film. What is more important, it is properly orthochromatic. Our unequaled experience with plates and films has enabled us to make and maintain in *Kodak N. C. Film the most perfectly balanced film in the rendering of color values.*

OTHER QUALITIES. Kodak N. C. Film adds to its superiority in rendering of true color values—the highest speed, freedom from halation, duplex paper (red on one side and black on the other) which absolutely does away with the offsetting of numbers on the film, latitude, which in the greatest degree compensates for errors in over and under exposure, and above all, *dependability*. It is the dependability of Kodak film that makes it the film invariably chosen in every event of world wide importance —the film chosen for making news pictures everywhere.

***That Dependability which makes Kodak Film the film invariably chosen for Events of Importance, makes it preferable for every-day use.***

EASTMAN KODAK COMPANY, Rochester, N. Y., *The Kodak City.*